POWER PLANT ENGINEERING

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Great Falls Hydro-Electric Development

FALLS VILLAGE PLANT SUPPLIES ITS QUOTA OF 9000 KW. TO THE MAIN POWER LINES OF THE CONNECTICUT POWER CO.

AT GREAT FALLS on the Housatonic River, in the midst of the Berkshires, near Falls Village, Connecticut, just south of the Massachusetts line, is the Falls Village hydroelectric plant of The Connecticut Power Co. This plant supplies, under normal operating conditions, about 10,000 kw. at 66,000 v. to the main power lines of this company which form a network over a large area in the Northwestern section of the state.

The properties of the power company, of which there are several, are managed by Stone & Webster, Inc., who designed and constructed this installation. It shows the same careful design that characterizes all of the Stone & Webster, Inc., plants, small as well as large.

This station is a beautifully finished, modern, three-story brick and concrete building which contrasts quite sharply with the quaint old-fashioned frame structures of the quiet little village. It is located on the east bank of the river, at a point where the river takes a turn toward the west, below a hill that partly hides it from view of the town.

In the original design of this installation, a total capacity of 15,000 kv.a. divided among four units was

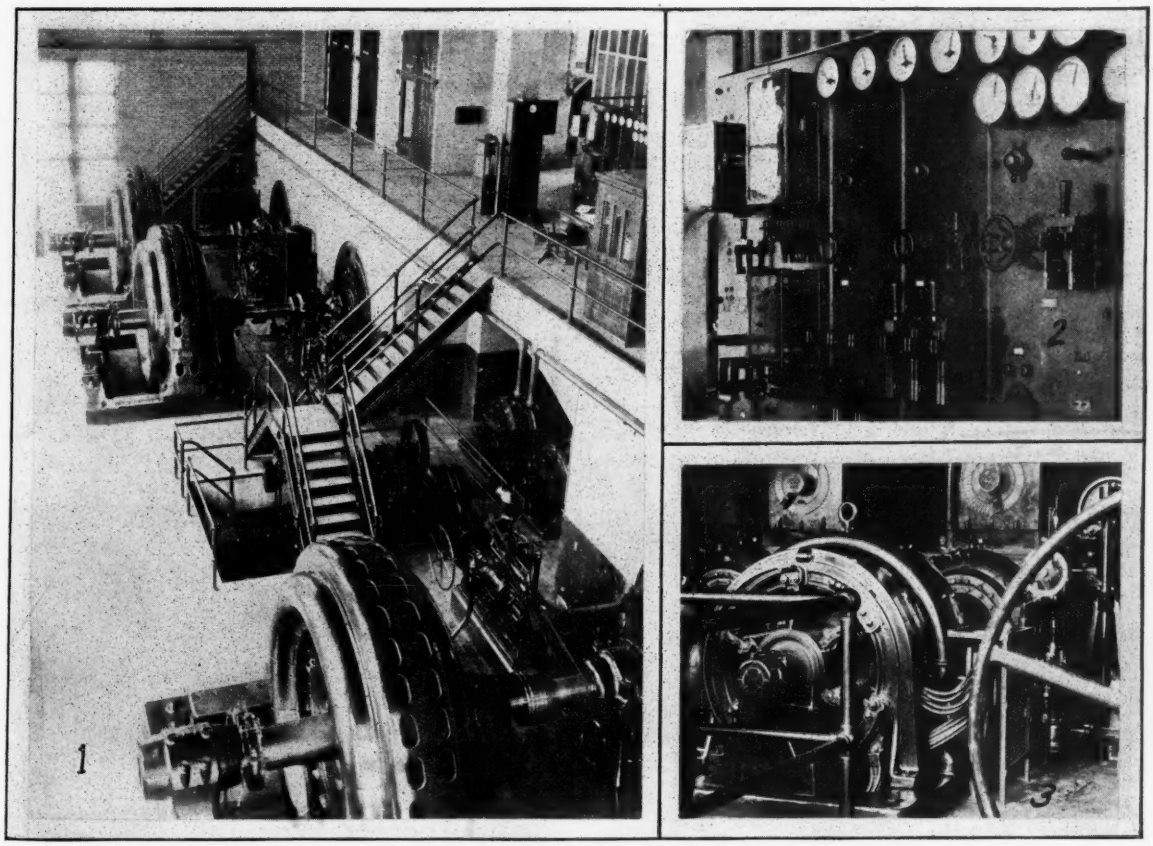


FIG. 1. LOOKING DOWN ON THE GENERATOR ROOM

FIG. 2. A SECTION OF THE MAIN SWITCHBOARD

FIG. 3. TURBINE-DRIVEN EXCITER UNIT

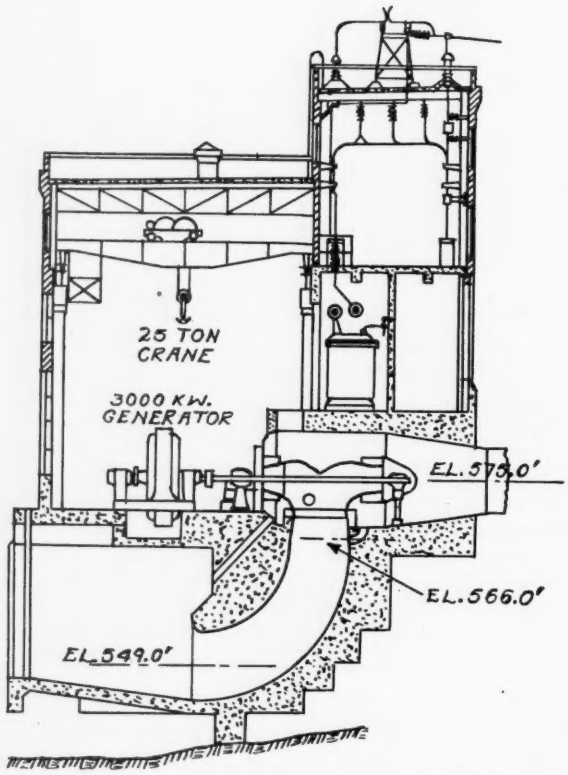


FIG. 5. SECTIONAL ELEVATION OF THE STATION

specified, but up to the present time only three units have been installed. The fourth will be put in when the system load increases sufficiently to enable the additional secondary power to be sold to advantage.

The plant is located, not immediately adjacent to the falls and dams, but down stream a distance of perhaps a third of a mile, where it is possible to obtain a much lower tail water level, as the fall is not all concentrated in one spot. The fall proper constitutes about three-quarters of the total drop; the rest is made up of a stretch of rapids over a bowlder strewn river bed.

At the crest of the falls is a reinforced concrete dam that raises the water level to an elevation of 659 ft. above sea level (99 ft. above tail water). From the reservoir thus formed the water spills 9 ft. through a set of remote controlled, motor operated head gates to the canal leading to the fore bay of the station.

The canal, about 20 ft. wide. is constructed of reinforced concrete and is built into the side of the hill forming the east bank of the river where it follows the right-of-way of the New York, New Haven, and Hartford railroad, a distance of 1600 ft. to the fore bay of the plant, immediately back of the station.

At this bay is another set of head gates, in this case manually operated, that controls the flow of the individual penstocks of each turbine. These gates are kept full open or entirely closed, depending on whether or not the turbine which each supplies is in operation. The effect of the normal fluctuations of the generator

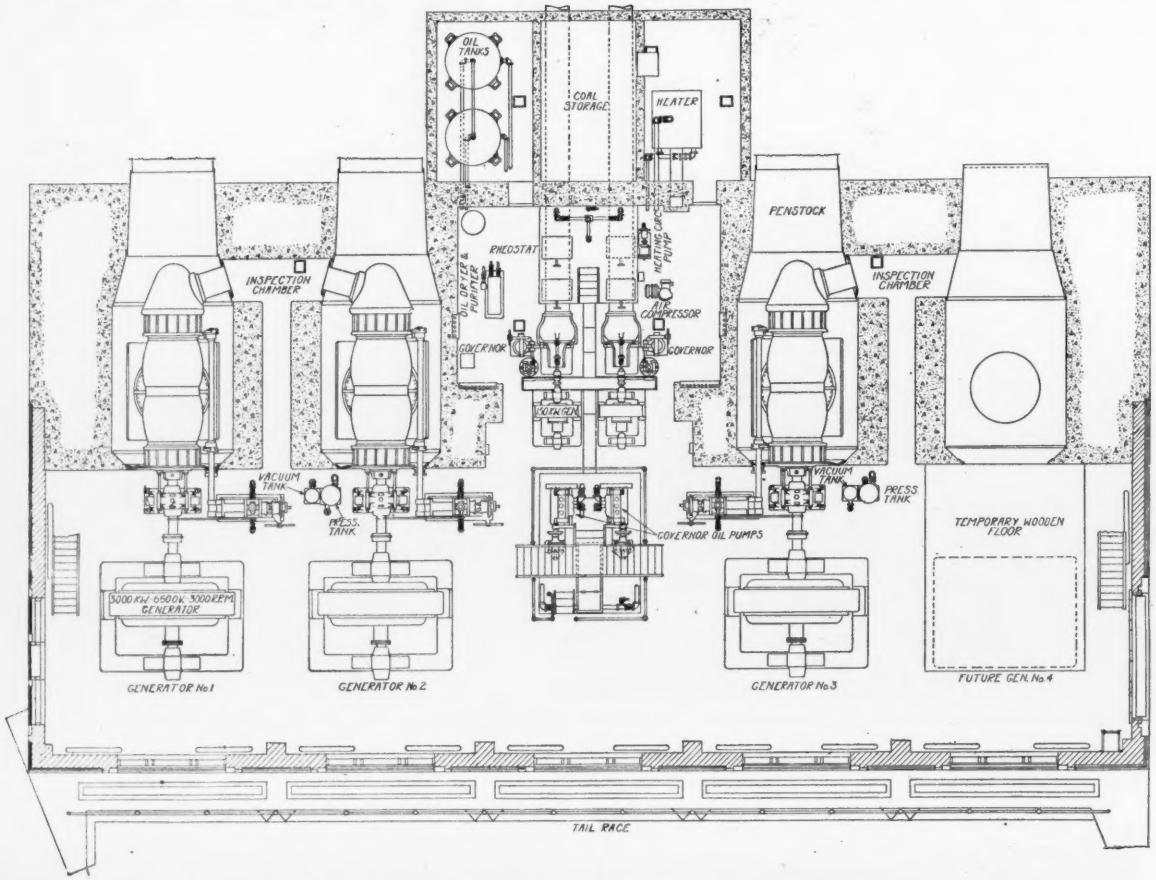


FIG. 4. FLOOR PLAN SHOWING LOCATION OF VARIOUS UNITS

load on the flow is taken care of by the regulation of the gates at the dam.

Water is conveyed under pressure from the fore bay to the turbine through three 8-ft. diameter, steel plate, underground penstocks for a distance of perhaps 150 ft. At the turbine the section is gradually enlarged to 13 ft.

Turbine and Generator

The turbine, a cross-sectional view of which is shown in Fig. 6, is of the horizontal, double runner, balanced thrust type built by the Wellman-Seaver-Morgan Co. The flow is from both ends radially inward and then axially toward the center where dis-

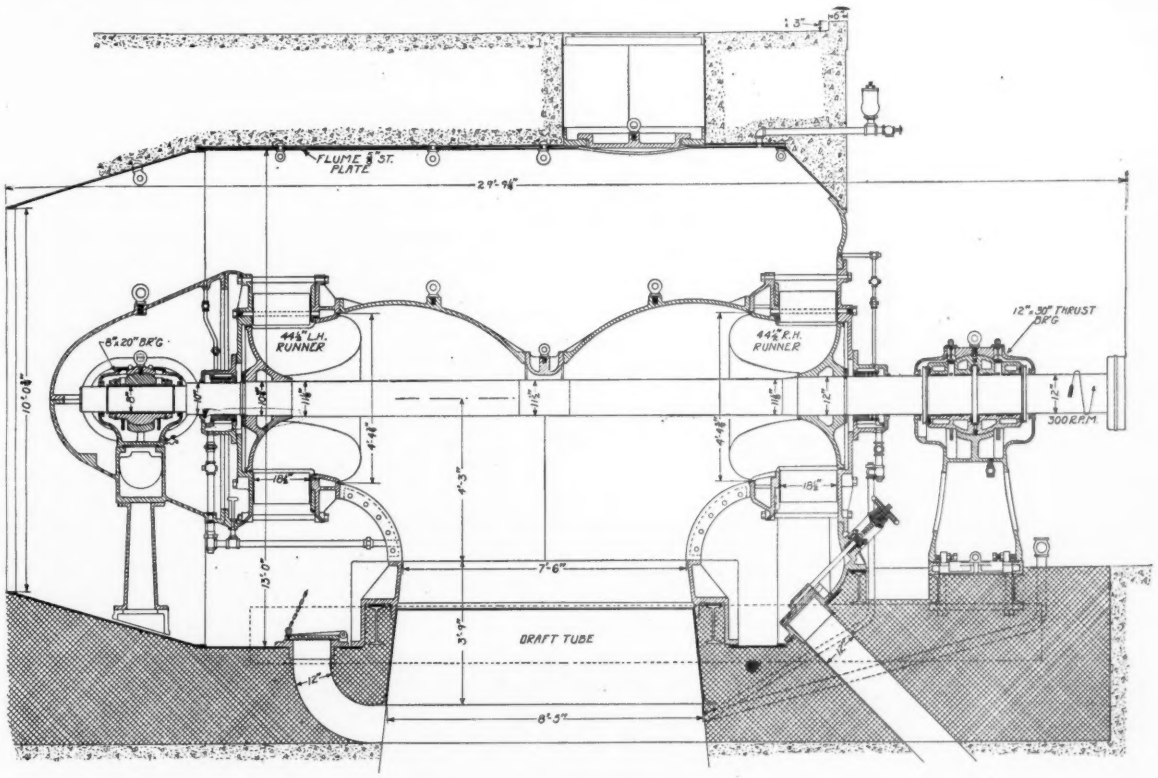


FIG. 6. SECTION OF THE MAIN TURBINE

diameter to accommodate the turbine. At this point it is molded into the concrete foundation of the plant.

In Fig. 4 may be seen the floor plan of the generator room showing the relative positions of the generators, turbines, exciter units, governors, etc., and in Fig. 5

charge takes place through a draft tube connected to the center of the wheel case. The casing is cylindrical in section and well stream lined to offer as little resistance as possible to the flow of water. This applies particularly to the nose on the upstream end of the

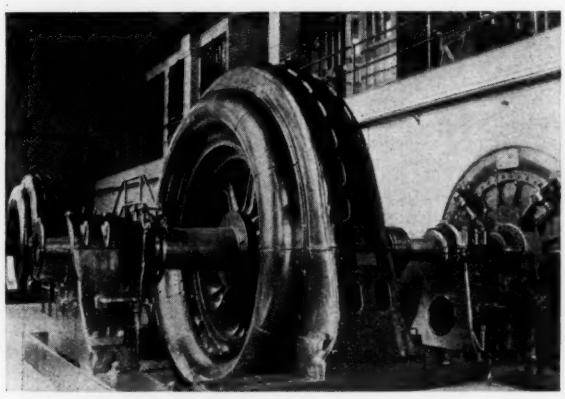


FIG. 7. 3750-KV.A. ALTERNATOR

an end elevation looking north, showing the location of the high tension room in relation to the rest of the plant.

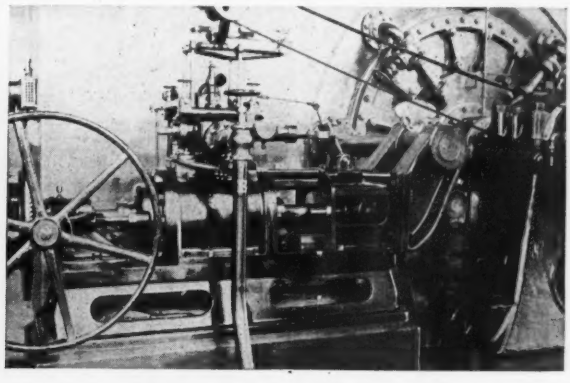


FIG. 8. RELAY TURBINE ENGINE

shaft which encloses the outboard bearing. The shape is very similar to that of the nose of a torpedo.

Water is admitted to the two right and left-hand 44½-in. runners through two sets of wicket gates or

guide vanes 18½ in. high, operated through two reach rods from the governor shaft. These runners are cast of steel in one piece and are keyed onto a steel shaft which varies in diameter from 8 in. at the outboard bearing to 12 in. at the generator coupling.

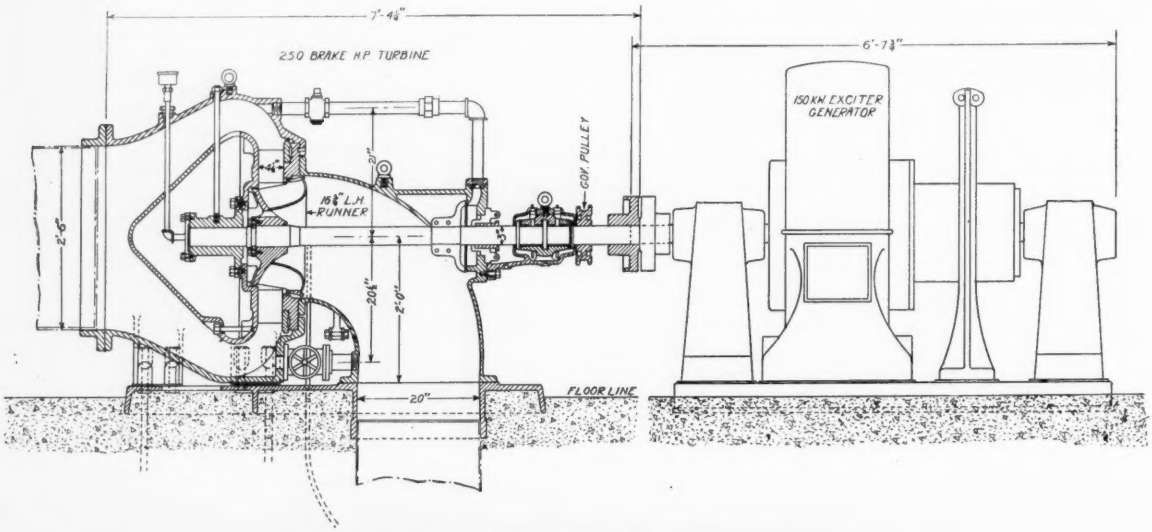


FIG. 9. EXCITER AND SECTION OF EXCITER TURBINE

The center line of the shaft is at an elevation of 575 ft. or just 75 ft. below the level of the forebay. From the turbine the drop to tail water is 15 ft., making a total drop available for conversion into mechanical power of 90 ft. The draft tube, at the point where it joins the wheel case, has a diameter of 7 ft. 6 in., causing a velocity of flow, at rated capacity, of about 14½ ft. per sec. This tube takes a sweep through 90 deg. to horizontal and its section gradually changes to an approximate ellipse. At the same time the area of the section increases until at the entrance to the tail race it is 9½ by 16½ ft. and has an area of approximately 140 sq. ft. The velocity of flow at this point is then about 4.5 ft. per sec. The turbine is rated at 5000 brake hp., and at this rating uses about 625 cu. ft. of water per second.

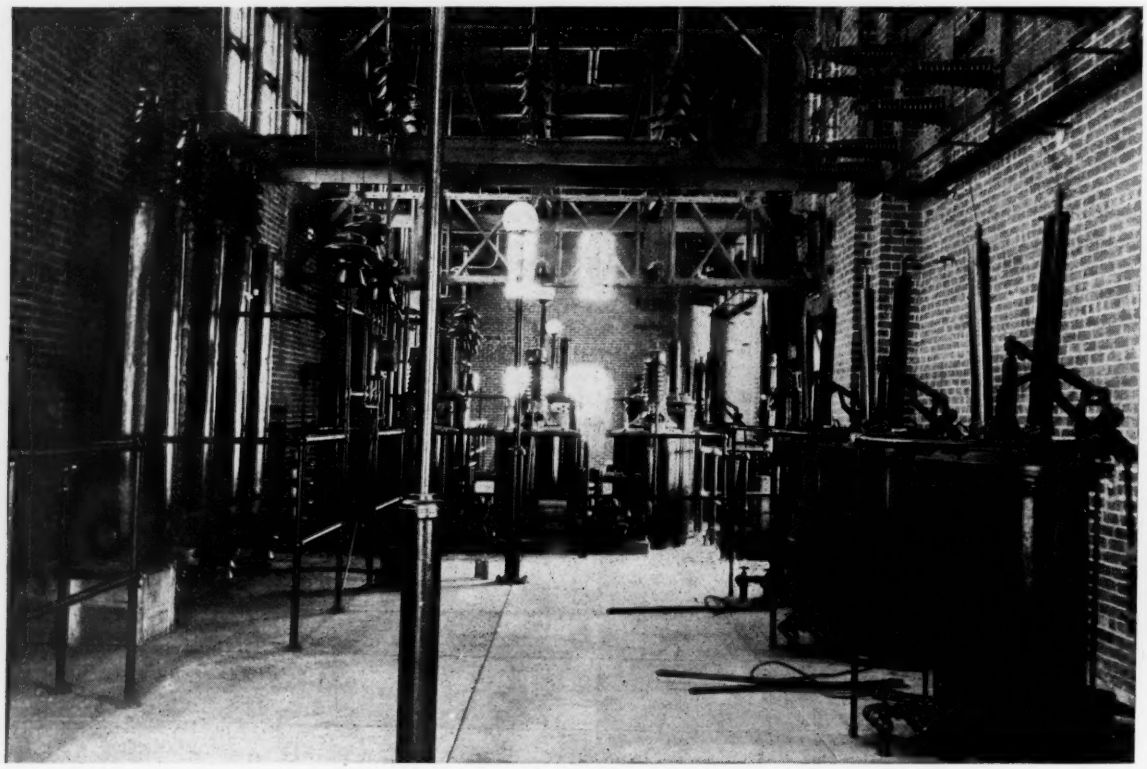


FIG. 10. GENERAL VIEW OF THE 66,000-V. HIGH TENSION ROOM

Direct-connected to the turbine shaft is an Allis-

Chalmers 3750-kv.a., 6600-v., 3-phase, 329-amp. per phase, 60-cycle generator as shown in Fig. 7.

Under actual conditions normally obtaining, the power factor on the system averages around 80 per cent so that the actual output of the machine is about 3000 kw. This machine is of the horizontal revolving field type, has 24 poles and is designed to run at 300 r.p.m. The field piece is provided with a set of fan blades on its periphery that serves to keep a current of air moving over the field and armature coils to keep down the temperature.

Governor

Belt driven from the main turbine and generator shaft is a Lombard pressure relay governor, a side view of which is shown in Fig. 8. Any change in the generator speed acts to open a piston valve in communication with the main oil cylinder. If, for instance, on the installation shown, the load on the generator is decreased, the turbine will speed up, and this change in speed will cause the valve to move so as to allow the oil in the crank end of the main cylinder to escape and at the same time will open another port to admit oil to the head end. The pressure thus exerted in the head end will move the piston to the right. This movement is transferred through a crank to the governor shaft which will be rotated through a small angle in a counterclockwise direction. This rotation is imparted through two sets of two reach rods, to the gate ring which also moves in a counterclockwise direction and partially closes the wicket gates at either end of the turbine. When the speed has been reduced, the valve closes and the piston assumes a position of equilibrium. Indicators on both the shaft and the crosshead serve to show the per cent gate opening at any time. Geared to the tail rod of the oil piston is a hand wheel by means of which it is possible to operate the gates manually, if for any reason the governor is put out of commission.

Oil pressure is obtained from a single acting, triplex, motor driven, Deane pump which can be seen under the stairway leading to the switchboard gallery, in the birds-eye view of the generator room, Fig. 1. One pump is of sufficient capacity to take care of all three turbines, but they are installed in duplicate to insure continuity of service. This pump is driven through a magnetic clutch and gear train. In operation, the motor runs continuously but the pump is at rest except when there is a change in the load on the generator. When any change in the position of the turbine gates is required, a relay on the governor acts to close a circuit which energizes the magnetic clutch and so start the pump.

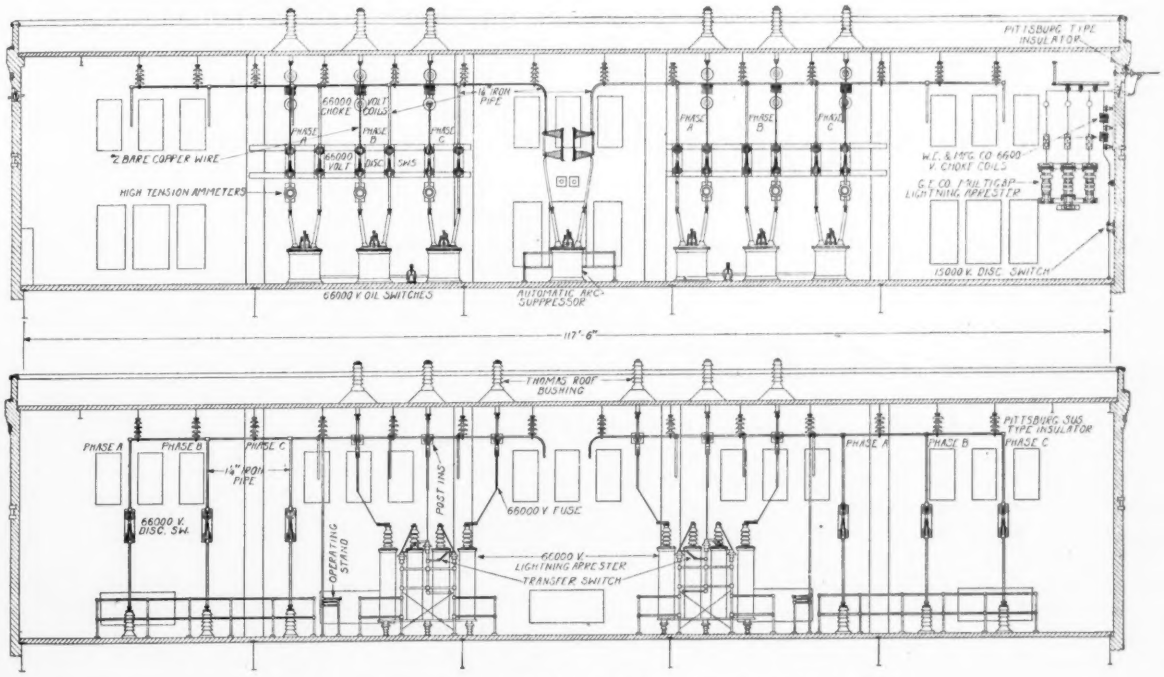


FIG. 11. LONGITUDINAL SECTIONS THROUGH HIGH TENSION ROOM

Exciter Unit

Excitation current is supplied by either one of two duplicate exciters, located in the bay under the balcony, Fig. 3, each of which is driven by a 250-brake hp. 600-r.p.m. Wellman-Seaver-Morgan hydraulic turbine, supplied by a separate 3-ft. penstock, Fig. 9. The penstock decreases in section before it reaches the wheel case of the turbine until, at that point, it has a diameter of 2 ft. 6 in. Just back of this point, the wheel case flares out around a cone-shaped deflector over the upstream bearing which guides the flow outward and then radially inward toward the single runner mounted on a horizontal shaft. Guide vanes 4½ in. high direct the flow spirally inward onto the blades of the 16¾-in. runner, which is mounted on a 3¾-in. diameter shaft which drives the generator shaft through a flange coupling.

The draft tube, 20 in. in diameter, sweeps downward from the runner and gradually enlarges its sec-

tion to 3 ft. 9 in. diameter where it empties into the tail race. The water requirements of this unit at full load are about 50 cu. ft. per sec.

This turbine is also governed by a Lombard governor of the same general type as those used in connection with the main units.

The exciter generator, built by the Allis-Chalmers Mfg. Co., operates at 125 v. and has a capacity of 1200 amp. or 150 kw., which is ample to excite the three main units. The voltage to the main generators is controlled by means of a Cutler-Hammer resistance box which is mechanically operated by the voltage regulator on the switchboard.

Each of the three-phase leads from each generator are connected to three common 6600 v., A, B and C phase generator busses on the balcony of the generator room where there is located the control board, the operator's desk, the transformers, etc. There are six of these transformers rated at 2500 kw. each, arranged in two sets of three each, each set supplying a high tension system at 66,000 v. The two sets are connected in parallel, delta-delta, between the generator busses and the two high tension systems, each phase of which carries a current at rating of about 49 amp.

Figure 10 shows a view of the high tension switch room and Fig. 11 a schematic layout of the connections. In this room may be seen the large oil circuit breakers, one on each 66,000-v. feeder, the electrolytic lightning arresters, and the automatic arc suppressors. These arc suppressors are motor driven and so operate that one phase is momentarily grounded if for any reason a ground occurs on the line. The first operation is to open the circuit long enough to extinguish the arc and then close it again. If the ground persists the circuit is opened permanently until the trouble can be located and a repair effected.

During the year the flow of the Housatonic varies widely, from as little as 100 cu. ft. per sec. during the short dry season to as much as 4000 cu. ft. during the rainy season. This condition is, it is to be presumed, the reason for the extra 9 ft. of reservoir capacity.

Priming and Control of Boiler Water Concentration

CONSIDERABLE ECONOMIES ARE EFFECTED BY ELIMINATION OF PRIMING. BY GEO. C. COOK

BOILER PRIMING is often the cause of serious troubles in the power plant. Priming may occur intermittently in the form of slugs carried over into the steam lines from the boiler or under certain conditions continuously in the form of entrained moisture in the steam. Priming may be due to a number of different causes, among which may be enumerated improper boiler design, high overloads, water level in drums carried too high, and too great concentration of impurities in the boiler water. The features of design affecting the tendency of the boiler to prime are the amount of free area allowed in the drums and headers for the disengagement of the steam and water, the manner of removing the steam from the drums, and the use of dry pipes or other devices (such as an additional drum used as a separator) to reduce the amount of entrained moisture.

In one installation where trouble was encountered due to priming, the boilers were of the inclined water tube type with two longitudinal drums and solid headers. There were three saturated steam connections taken from the rear header at a height 6 in. above the normal water level in the drums and carried in a downward direction to the superheater header. It was found that when these boilers were forced, the surging in the drums would carry the water up into the steam outlets and form a siphon into the superheater, carrying heavy slugs of water into the steam main. This condition was improved by riveting cup-shaped baffles to the inside of the rear header over the steam outlets thus tending to prevent the surging carrying water into the outlets. Too high a water level is sometimes purely the result of careless operation, sometimes the result of faulty operation of feed-water regulators, or feed pump governors, and sometimes the result of scored seats in the feed valves. The concentration of impurities in the feed water increases the tendency to priming and it will be found that for any given case there is a degree of concentration which cannot be exceeded without trouble from priming. The determination of this limit and the methods of controlling the degree of concentration is the subject of this article.

EVILS OF PRIMING

THE EVILS of priming are many: slugs of water carried over into the steam lines may cause serious damage to turbine blading or reciprocating units. Where moisture is carried with the steam there will be a loss in economy, erosion of turbine blading and a tendency for the deposit of saline salts in the steam lines, superheater tubes, valves, etc. The writer has known of cases where the accumulation of these salts around the seat of the non-return valve was such as seriously to cut down the output of the boiler. In another plant, trouble was experienced with the complete stoppage of the turbine strainers, taking units off the line to clean the strainers being a daily occurrence. The strainer stoppage was caused by slugs of water carried over from the boilers, washing the accumulated saline deposits from the feed lines on to the strainers, in many cases completely covering it; on removing the strainer these deposits were usually washed off with a hose. This strainer trouble was practically remedied by installing a small water jet in the main steam lead so as to impinge on the strainer. By the use of this jet when the drop through the strainer was seen to be increasing, it was frequently possible to keep the machine in service without removing the strainer for cleaning. The final solution of these troubles was accomplished, however, by removing the cause, that is the priming of the boilers. In boilers equipped with superheaters the degree of superheat to be obtained is based upon the assumption that the boiler shall deliver dry steam to the superheater and since one per cent of moisture will result in a 15 deg. reduction in superheat it will be seen that the elimination of priming is, if possible, most desirable.

The concentration of salts in the boiler water and the amount of insoluble matter suspended in the boiler water both influence the amount of priming. To determine both of these requires a somewhat complicated procedure; the relative concentration of the salts, however, is easily obtained and since the ratio between the salts and the insoluble suspended matter is for any given water reasonably constant, the determination of the salt concentration may be used for purposes of control. In making this determination, either of two methods may be used, chemical or electrolytic.

Chemical Methods

Where sea water is used for condensers and the chief source of impurities in the boiler water is from condenser leakage, a chlorine determination may be used as an index of concentration. The chlorine determination is made in the following manner: 50 c. c. of a water to be tested is placed in a heater and three drops of a saturated solution of potassium chromate is added for an indicator. Silver nitrate 1/10 normal is added from a burette until a faint pink color is obtained. The number of c. c. of the silver nitrate solution is an index of the concentration.

Where the impurities in the water are principally sodium carbonate and sodium hydrate, a determination of the causticity can be used. This determination is made in the following manner: To a 50 c. c. sample of the water to be tested in a beaker is added two drops of phenol-phtalein solution as an indicator which will color the sample pink. A 1/5 normal solution of sulphuric acid is added from a burette until the pink color is just destroyed. The number of c. c. of acid used is an index of the degree of concentration.

In using the above determinations to control the concentration of the boiler water within safe limits, it is necessary to determine the amount of concentration allowable, that is the point above which if the concentration is allowed to increase trouble will be experienced. The degree of allowable concentration will vary for each particular case, depending upon the type of boiler, the rating developed, and the character of the boiler water. To determine the allowable degree of concentration, a boiler would be placed in service with fresh water and run under normal operating conditions, a careful check being made upon the increase in concentration each day, by one of the methods given, at the same time a record being kept of the amount of moisture in the steam leaving the drums, by means of a throttling calorimeter. The degree of concentration at which the moisture in the steam reached an undesirable point would be the maximum to be allowed. The concentration should then be kept below this point by blowing down the boiler at frequent intervals. To aid in determining the amount necessary to blow down each time, a curve may be plotted between the relative degree of concentration and the amount necessary to blow down to reduce it to the pre-determined limit, this being a simple matter of proportion based upon the water contents of the boiler and the amount of water blown down by lowering the water level in the gage glass a certain number of inches.

Electrolytic Method

The determination of the degree of concentration by means of the chemical methods at frequent intervals for a plant containing a large number of boilers entails considerable work. Satisfactory results may be obtained by the electrolytic method in a much more expeditious manner. This method is based upon the fact that the degree of concentration of soluble salts in water affects its conductivity. The apparatus to be used in getting a relative measure of the conductivity of the water must be adapted to the range of concentrations to be met with and the instruments and currents which are available—a little experimentation will show the best arrangement. For example, at one plant an apparatus was used, constructed as follows: a U tube formed of two gage glasses connected at the bottom by a piece of rubber tubing was used for holding the sample of water. Electrodes of copper wire 3/16 in. in diameter were introduced through corks into the top of each leg of the U tube and extending down 3 in. into the water. The U tube was connected in series with a 300-v. d.c. voltmeter, having a resistance of 33,000 ohms, to 120 v. d.c. supply. The U tube was of such a length that the path of the current was 10 ft. The readings of the voltmeter were calibrated by means of the chemical method to read in terms of relative concentration. Since the conductivity is also dependent upon the temperature of the water, it is necessary to cool the sample to a standard temperature (say 70 deg. F.) before taking the reading.

Taking Samples

In using any of the above-mentioned methods of testing, care should be taken in obtaining the sample of water from the boiler. If the sample is taken from the water-column blow-down, the following procedure should be adopted: the water column should first be blown down in order that a sample of water from the drum shall fill the pipe, then 10 to 15 min. should elapse before taking the sample in order that the water in the pipes shall cool to such a point that it will not flash into steam when the valve is opened, which would increase the concentration of the sample above that of the water in the drum. Where boilers are set in battery, the sample, if possible, should be taken from the drum next to the party wall, since the water in this drum will show a higher degree of concentration than that in the drum next to the outer wall. This is explained by the fact that the rate of evaporation on the side next to the party wall is usually the greater.

General

The blowing down of boilers should always be done if possible at periods of light load, since at such times the circulation is slower and more of the suspended matter will settle in the mud drum and be carried away. If the water in the boilers be changed at such times as they are taken out of service for furnace repairs or similar reasons, it will usually be found that at other times the concentration can be controlled without excessive blowing down.

Another reason for avoiding high concentrations in the boiler water is that with a high concentration of soluble salts, together with suspended matter, a scale may be formed on the tubes which would not be formed with the concentration maintained at a lower point.

The foregoing methods of control have been found very satisfactory in practice. At one plant, in order to avoid priming trouble, it was necessary to change

the water in each boiler after six days operation with the result that the boilers would only be kept in service six days out of seven. Since the boiler capacity installed was limited, this made it necessary to operate the boilers at a high rating to carry the load. By these methods of controlling the concentration it was found possible to operate without changing the water except at such times as the boilers had to be taken out of service for furnace repairs. This, then, effected a considerable economy in cutting down the losses incidental to bringing cold boilers on the line and by allowing a greater number of boilers to be kept in service, each operating at a more efficient rating. At another plant, serious and frequent interruptions to service due to strainer stoppage at the turbines were eliminated by these methods.

Refinements of Practice in Modern Power Plants

Discussing the Advisability of Banking Fires; Features Regarding Furnace Construction and the Overcoming of Difficulties with Superheater Operation. By I. L. Kentish-Rankin

THE BANKED fire is such a common everyday affair that it comes in for comparatively little attention. In the average plant, the length of time a fire is banked and the coal required for banking are not considered worthy of a place on the log sheet. Therefore, what one naturally would expect to happen does happen; namely, banking becomes a haphazard proceeding in which fuel may be unknowingly and unnecessarily wasted.

Do you know how much coal is required for banking each and every furnace in your plant? Do you know how the amounts vary with the different batteries, and why? Have you ever troubled to find out the difference in coal required for banking for a period of 24 hr. and starting up after letting a fire go out? Every engineer should know these things, for without knowing them he cannot know when banking is being done economically or when it is better to let a fire go out instead of keeping it in, but passive.

It is generally more economical of coal to let a fire go out than to bank it if the unit will not be required for 24 hr. For example, a boiler with chain grate stoker requires about 3700 lb. of coal to bring it up to steam with cold water. For banking, this same unit will require about 4000 lb. although it may require more, and then again it may require only 3000 lb. under favorable conditions. Only when the actual requirements in each case are known with reasonable accuracy can the best procedure be ascertained. It should, of course, be borne in mind that this same boiler with a banked fire can be put on the line in about 15 min., whereas if the fire has to be lighted it will require about 45 min. Minimum stand-by loss is often subservient to availability for service.

A knowledge of the amount of coal used for banking different units for the same period of time leads the way to plant improvement as well as fuel saving. A discrepancy of 50 per cent in coal consumption for apparently identical units is not uncommon. Such a difference means a considerable quantity of coal in the course of a year, and one worth saving since the remedy is simple. Only by weighing the coal for banking and a little experimentation can the differences be found and the reasons overcome. Warped dampers that will not close at all or dampers so warped that they will not close tightly are frequent causes of high coal consumption for banking. Improper condition of the fuel bed previous to banking is another cause. The personal equation is an important factor, of course. Another condition that has a bearing is whether a boiler is cut off from the steam line or whether it must supply the condensation loss. In this latter case, the fuel consumption will be higher. Sometimes it is advisable to keep steam lines hot and sometimes it is better to close them down.

Every engineer should know the efficiency of each boiler and have a curve showing efficiencies at different loads. With these data it is possible to keep a boiler in service longer instead of banking, operating at reduced rating instead of taking it out of service. This is one way of saving coal by reducing that required for banking.

In seeking to cut off the draft through the fuel bed the stack damper should not be closed so tightly that the carbon monoxide and hydrocarbon gases cannot escape. Unpleasant explosions have taken place from this cause. It is better to leave the ashpit doors open and open the fire doors lightly if necessary rather than to close the ashpit, as to do so stops the ventilation under the grates and so encourages warping. Mechanical stokers may be damaged by careless banking, the links of chain grates burning open and the retorts of underfeeds fusing together; a fire should be well burned down before being banked.

Some companies use two grades of coal, the superior grade for peak and the inferior grade for light loads. Here, again, a little experimentation will show when it is profitable to mix the coals, what proportion of each to use, or which coal makes the cheaper bank. Many plants would find it financially worth while to use a mixture of hard-coal screenings and nut and slack at all times.

The coal used for banking is not a major item of plant operation. It may be 10 per cent to 30 per cent, depending upon the service, the load factor and the care with which the banking is done. The coal used deserves a place on the log sheet—it is one of those little refinements that mean so much toward the ultimate economy that every engineer strives to attain. Coal for banking is a stand-by charge and while it should be included in the weekly or monthly statement of pounds of steam or kilowatt-hours per pound of coal it should be isolated in the daily log.

How much coal is consumed for banking depends upon the length of time banks are in use, the size of boiler, the type of stoker or hand firing, the condition of the dampers and the care with which dampers are set and the fire banked. For a given plant, maintenance of equipment and supervision of operation are the two factors that finally determine whether minimum coal shall be used for banking. Keep tab on it, since this is the starting point for economy.

Flame Travel a Function of Furnace Performance

Ample furnace volume is now recognized as being of great importance. It enables better mixing of gases and air, hence results in higher combustion efficiency and the abatement of smoke, since the hydrocarbons will be consumed instead of being cooled off by the boiler surfaces to pass up the stack. Most reports on boiler rooms contain some allusion to furnace volume, expressed generally as so many cubic feet, and sometimes as so many cubic feet per square foot of grate or boiler surface or per pound of coal.

It should be remembered, however, that volume is the product of three dimensions, namely, length, height and width. Volume gives opportunity for the mixing of air and gases. But another element enters also, namely time. It takes time for gases and air to mix and if insufficient time exists, insufficient mixing will occur and combustion will be incomplete. The distance traveled by the furnace gases after leaving the fuel bed until they reach the boiler surfaces is a vital factor in determining not only combustion efficiency but furnace capacity. Distance is of one dimension; it is no less important than volume. With orthodox furnace designs, increased furnace volume automatically means increased flame travel so that better mixing of air and gases occurs with greater length of time for mixing and combustion.

But as flame travel is so important does it not deserve to be segregated, instead of being included as a function of volume? It is possible, though unlikely, to increase volume while shortening the flame travel. One often hears the statement that so many cubic feet of furnace space are required for certain coals, depending upon the volatile. Yet nothing is said about length of flame path. Volume gives the requisite condition for mixing; distance gives the time element for the completion of oxidation. Boiler heating surfaces cause soot only because they cause the hydrocarbons in the gases to be cooled off before they can be burned.

Data of immense value would be that which gives the length of flame travel as well as the furnace volume. Reports of such renowned plants as that of Henry Ford, the Calumet station of the Commonwealth Edison Co., and others would be much enhanced if they contained statements as to the length of time the gases remain in the combustion chamber for different combustion rates and the length of flame travel. It is only of recent years that the combustion space, in cubic feet, has been given. Why not go a little further and state the time element also? It seems that each cubic foot of gas remains in the combustion chamber less than 1 sec., often less than ½ sec. How does this vary with different settings and at different rates of combustion and how do smoking and efficiency vary?

How the flame travel affects performance was emphasized a year or more ago in one of the largest pulverized coal installations. Because of an ash conveyor it was impossible to install the coal burners horizontally as had been the custom; instead they were installed vertically. The flame then passed downward, turned and rose again toward the boiler surfaces. The flame travel was increased more than 100 per cent. What was the effect? The mixing of air and fuel was better and combustion higher; the flame no longer impinged against the boiler tubes or against the refactories, so increasing the life of both; molten clinker and ash lost velocity and so fell down into the ashpit instead of being driven with considerable impact against the tubes and out of the stack. The largest pulverized coal installation is using a long flame travel in the same way.

It has taken several years of education to show that larger furnace volumes were required. It requires education to prove the importance of flame travel, or time element, upon furnace capacity and combustion efficiency.

Corrosion of Superheaters

Some day superheated steam will be used in this country to the extent that it deserves to be and then many comparatively small industrial plants using comparatively low steam pressures will employ around 100 deg. F. of superheat with all its benefits in the way of higher over-all economy, less loss and trouble due to condensation, and small piping or as a safe way out where lower pressures must be used on the score of safety. At present, as a general thing, the larger plants, only, use superheat.

When superheaters become more general, some new problems will develop and the properties of boiler water and the reasons for boiler priming will come in for their quota of investigation. Superheaters, like boilers, will corrode, although in this country comparatively little trouble has as yet been experienced. When priming is prevented corrosion will be stopped. In the larger plants, where the boiler water is either of satisfactory condition or treated, the worst trouble due to priming now being experienced is on account of the variations in the degree of superheat. Priming, as we now all know, may be due to the constituents of the water; to insufficient steam disengaging surface; insufficient space between the disengaging surface and the steam outlet; to poor water circulation; extreme changes in evaporation rate; the sudden opening of a large valve and improper feeding of the feed water. Often it is a combination of several of these.

The partial stoppage of superheater tubes is due to priming and solids in suspension being carried over into the superheater. These solids may be quite corrosive; and this phase of the matter may be of even greater importance than the lowering of the superheat when priming takes place. It must be remembered that the temperature of the superheater is higher than that of the boiler; matter thrown down on the superheater tubes is exposed to this high temperature as well as to the continual stream of superheated steam. The high temperatures, 500 deg. F. and higher, and the concentration of salts give rise to very different condition to those that exist in the boiler with its lower temperature and its weak solutions.

A water producing an alkaline reaction in a boiler may produce acid in a superheater. Superheated steam is always well charged with free oxygen; steam usually contains carbonic acid. Salts such as sodium nitrate, innocuous in the boiler, are decomposed when heated in the dry state in the superheater. The carbonic acid changes to carbon monoxide as hydrogen is liberated under the action of the superheater iron upon the steam, reducing magnetic oxide to metallic iron and passing back to carbonic acid again.

There is the deposit or film common to all super-

heaters; then there are the deposits that depend in character upon the constituents of the water from which they are derived. Pure steam causes a film to form and which, of itself, serves as a protective coating so long as the steam is not charged with any contaminating properties. This film is magnetic oxide and is caused by the decomposition of steam (at 500 deg. F. and above) by metallic iron. Hydrogen is evolved and the magnetic oxide of iron results.

Sludge in the boiler water due to improper treatment, absence of or excess of treatment, is largely responsible for slogged superheater tubes. Material of this sort is invariably high in carbonate of lime which is converted into calcium hydrate and carbonic acid in the superheater, the former being precipitated, the latter passing off.

Nitric and hydrochloric acid are probably the major causes of corroded and pitted superheater tubes. Priming is especially objectionable under these conditions, as when the steam becomes dry in the superheater, the nitrates of magnesia and lime fall as solids. These decompose when in contact with metallic iron at superheater temperatures and so form nitric acid. Nitric acid corrodes the superheater, of course, and contaminates the condensate. Hydrochloric acid is formed much in the same way. The chlorides of magnesium and sodium are carried over into the superheater during priming to form hydrochloric acid upon heating. Ferrous oxide forms which is changed to ferric oxide under the influence of the free oxygen in the superheated steam. The foregoing explains, rather roughly, why superheater tubes sometimes corrode comparatively rapidly, especially in marine service.

The fact to bear in mind is that priming is the cause, since without priming or foaming the salts in the boiler water would not find entry into the superheater.

Speed Regulation of Hydraulic Turbines---II

PRINCIPLES AND METHODS OF CALCULATION INVOLVED IN THE DESIGN OF HYDRAULIC TURBINE GOVERNORS. BY JOHN S. CARPENTER*

IN ORDER to illustrate the use of the formulas given in the preceding part, we will now take three practical examples typical of modern practice and solve them.

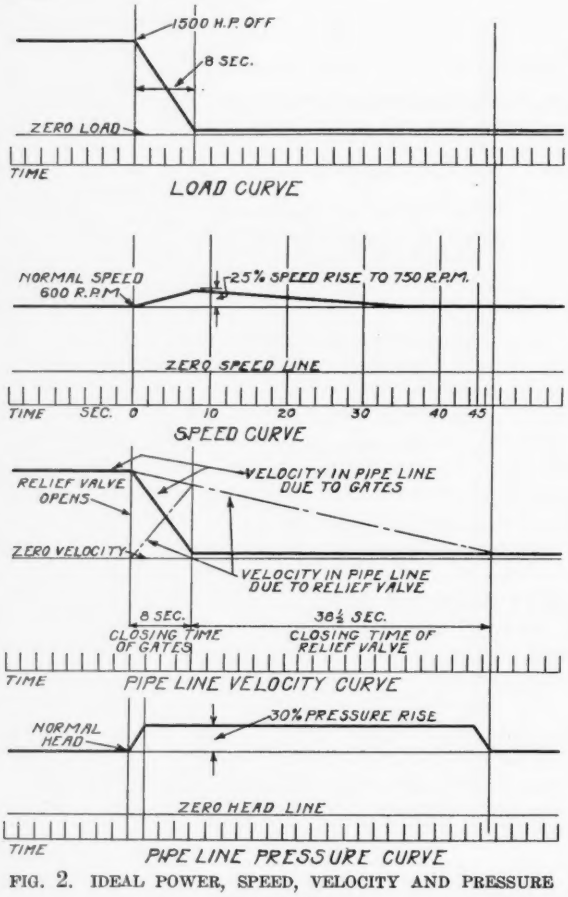


FIG. 2. IDEAL POWER, SPEED, VELOCITY AND PRESSURE DIAGRAMS

Example 1. A low head plant with a relatively slow-speed generator.

Given data: 16-ft. head; 850 hp.; 120 r.p.m.; generator WR^2, 120,000; runner WR^2, 50,000.

For an open flume installation of this type, a value of C (see equation 7), of between 4,000,000 and 5,000,000 is recommended to keep the speed variations at full load to reasonable figures. The closing time, t, can be taken as one sec. in most open flue work. Let us first see what value of C would be given by the WR^2 above, 170,000.

$$C = \frac{170{,}000 \times 120 \times 120}{850} = 2{,}880{,}000 \text{ (equation 7).}$$

Since this is not enough, we will reverse the procedure and solve for WR^2 directly, taking C as 4,500,000:

$$WR^2 = \frac{4{,}500{,}000 \times 850}{120 \times 120} = 266{,}000$$

As there is already 170,000 in the generator and runner, a balance of 96,000 will have to be made up in a flywheel. In this case, a 10-ft. flywheel can be gotten through the generator stator. Assume that the radius of gyration will be 46 per cent of the flywheel diameter, or 4.6 ft. This squared is 21.2 ft., resulting in a flywheel rim weight of 4530 lb. and a rim section of 8-in. face by 6¼ in. deep. Checking back shows the radius of gyration to be 22.5 instead of the assumed 21.2, permitting a weight reduction of 6 per cent. The next question is, what regulation can be expected? Substituting in and solving equation (6), we have

$$d = \frac{850 \times 81{,}000{,}000}{266{,}000 \times 120 \times 120} = 18 \text{ per cent speed variation}$$

with full load off. From careful tests on governors, the speed variation for three-quarter, one-half and one-quarter loads off is 60, 35 and 15 per cent respectively of the full load figure. Tabulating the results as follows, we have:

* Assistant hydraulic engineer, Worthington Pump & Machinery Corp.

Load change in per cent	Speed change in per cent
100	18
75	10.8
50	6.3
25	2.7

The above speed variations are the maximum to be expected and are for a plant operating alone. In the instance of a plant running in parallel with others, it is correct to take the WR^2 of the whole connected system; including that of all the generators, turbines and synchronous motors being driven. This often results in a computed speed variation as above being greatly damped and the load changes greatly smoothed out. This is especially true if there are any steam turbine units tied in with the water turbines.

Example 2. A medium head plant with fairly high speed generators.

Give data: 150-ft. head; 1500 hp.; 600 r.p.m.; 42-in. diameter pipeline, 500 ft. long; velocity in pipeline, 11.4 ft. per sec. at full load. Generator WR^2 given as 13,500; runner WR^2, negligible.

Let us first find the closing time, which directly involves the amount of pressure increase allowable. At this head, a rise of 30 per cent is conservative and will be used, being 45 ft. head. Solving (16a), we get

$$t = \frac{2 \times 500 \times 11.4}{32.2 \times 45} = 7.9 \text{ secs.}$$

Assuming a speed variation of 25 per cent at full load off, the WR^2 can be found from equation (18)

$$WR^2 = \frac{1500 \times 500 \times 11.4 \times 5{,}000{,}000}{45 \times 600 \times 600 \times 25} = 105{,}600$$

Since there is 13,500 in the generator rotor, there is a balance of 92,100 to put into a flywheel. A 7.5-ft. steel-banded flywheel can be safely used. Assume the radius of gyration to be 46 per cent of the diameter, or 3.6 ft.; the weight of the resulting flywheel rim is 7080 lb., requiring a rim section of a trifle more than 12 in. face and 8¼ in. deep. Although this unit is by no means very large, still it is a question here whether it would not work out cheaper to introduce another means of improving the governing and reducing the weight of the heavy flywheel. However, for comparison, in the next example let us take a somewhat larger pipe but with a length 12 times as long as in the present case. Compare the closing times, the pressure increase, the WR^2 and the speed variations. The speed variation in this case would be as follows, using the same constants as above:

Load change in per cent	Speed change in per cent
100	25
75	15
50	8.7
25	3.7

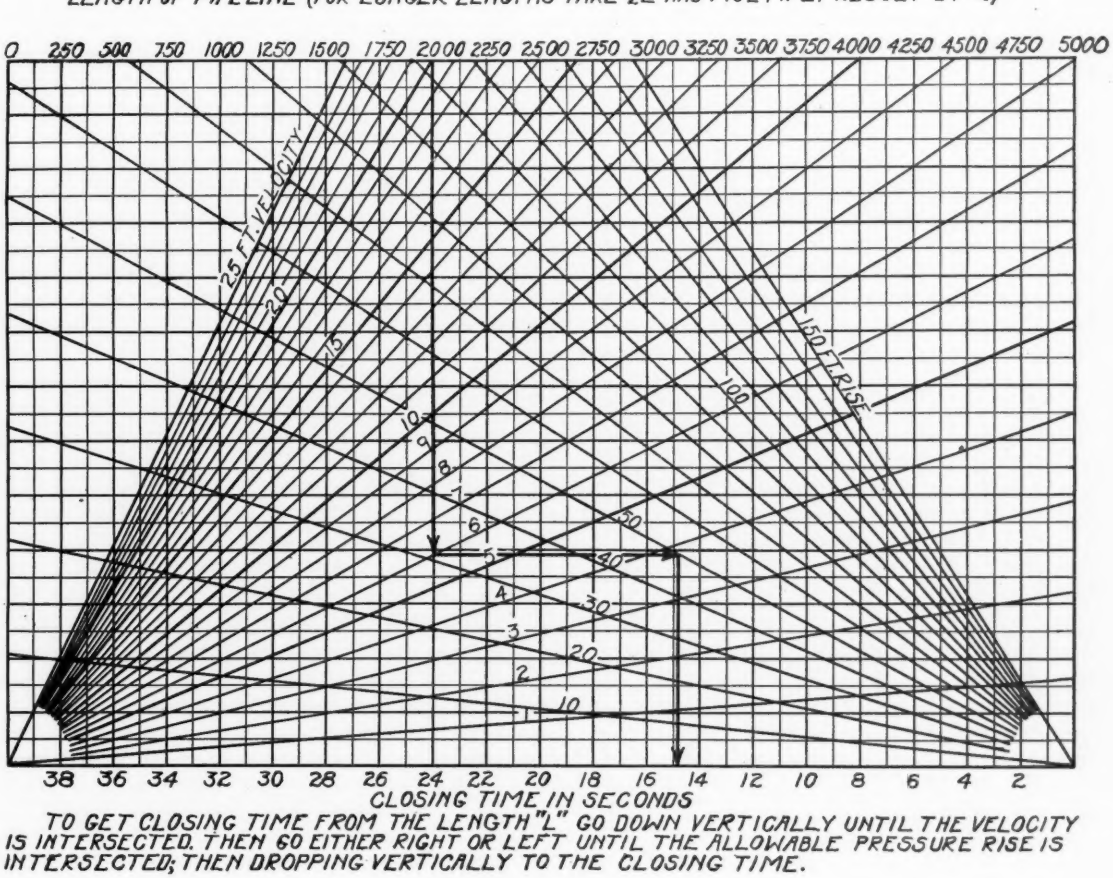

LENGTH OF PIPELINE (FOR LONGER LENGTHS TAKE ½L AND MULTIPLY RESULT BY 2)
0 250 500 750 1000 1250 1500 1750 2000 2250 2500 2750 3000 3250 3500 3750 4000 4250 4500 4750 5000
25 FT. VELOCITY
20
15
10
9
8
7
6
5
4
3
2
1
150 FT. RISE
100
50
40
30
20
10
38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2
CLOSING TIME IN SECONDS
TO GET CLOSING TIME FROM THE LENGTH "L" GO DOWN VERTICALLY UNTIL THE VELOCITY IS INTERSECTED. THEN GO EITHER RIGHT OR LEFT UNTIL THE ALLOWABLE PRESSURE RISE IS INTERSECTED; THEN DROPPING VERTICALLY TO THE CLOSING TIME.

FIG. 3. PRESSURE RISE CHART

Example 3. A medium head plant with very long pipeline.

Given data: 150-ft. head; 1500 hp.; 600 r.p.m.; 60-in. diameter; pipeline, 6000 ft. long; generator $WR^2 = 13{,}500$; velocity in pipeline, 5.6 ft. per sec. at full load. Let us assume a pressure rise of 50 per cent or 75 ft. The closing time is

$$t = \frac{2 \times 6000 \times 5.6}{32.2 \times 75} = 27.8 \text{ sec.}$$

It needs no second glance to see that a closing time like this is not practical. A flywheel to carry the "load on" conditions with a closing time like this would be quite a large wheel, not to mention the specially large bearings needed to support it.

A synchronously operated relief valve is the key to the solution of this problem. Even then a sizable flywheel will be necessary. Let us see how much velocity can be extinguished in a closing time of 8 sec. This can be obtained from (16a). Assume 30 per cent pressure rise or 45 ft.

$$v = \frac{45 \times 32.2 \times 8}{2 \times 6000} = 0.96 \text{ ft. per sec.}$$

Now 0.96 ft. is just 17.2 per cent of the normal full load velocity in the pipeline. So theoretically, at a full load rejection, we shall have to make a relief valve to discharge the balance, 83 per cent, of the full load water consumption of the turbine; thus keeping the pressure within the specified limit. The relief valve would be operated directly by the governor; opening as the governor closed the turbine gates, and set so as to close at the same rate of velocity reduction, that is in 38.5 sec. Refer to Fig. 2 and study the interrelated phenomena. There is an element of safety in the above figures in that the governor would not close the gates entirely, since it takes about 10 per cent of the full load water quantity to keep the unit at normal speed. If one desires to be quite exact about the exact rate of closing the gates and opening the relief valve, curves will have to be plotted showing the water quantities affected as a function of the governor stroke. With the usual designs, both curves will be found to be of the sine wave variety,

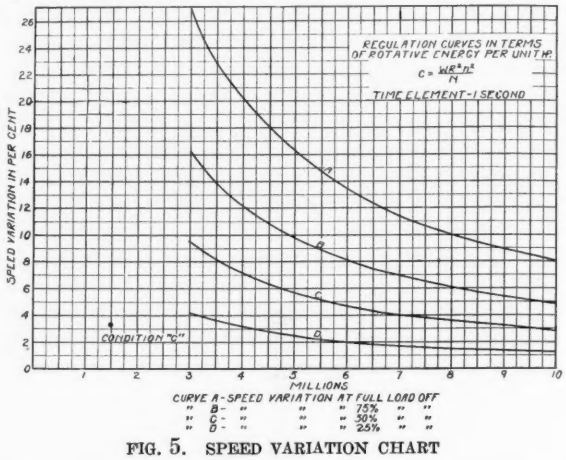

REGULATION CURVES IN TERMS OF ROTATIVE ENERGY PER UNIT HP.
$C = \frac{WR^2n^2}{N}$
TIME ELEMENT - 1 SECOND
SPEED VARIATION IN PER CENT
MILLIONS
CONDITION "C"
CURVE A - SPEED VARIATION AT FULL LOAD OFF
" B - " " " " 75% " "
" C - " " " " 50% " "
" D - " " " " 25% " "

FIG. 5. SPEED VARIATION CHART

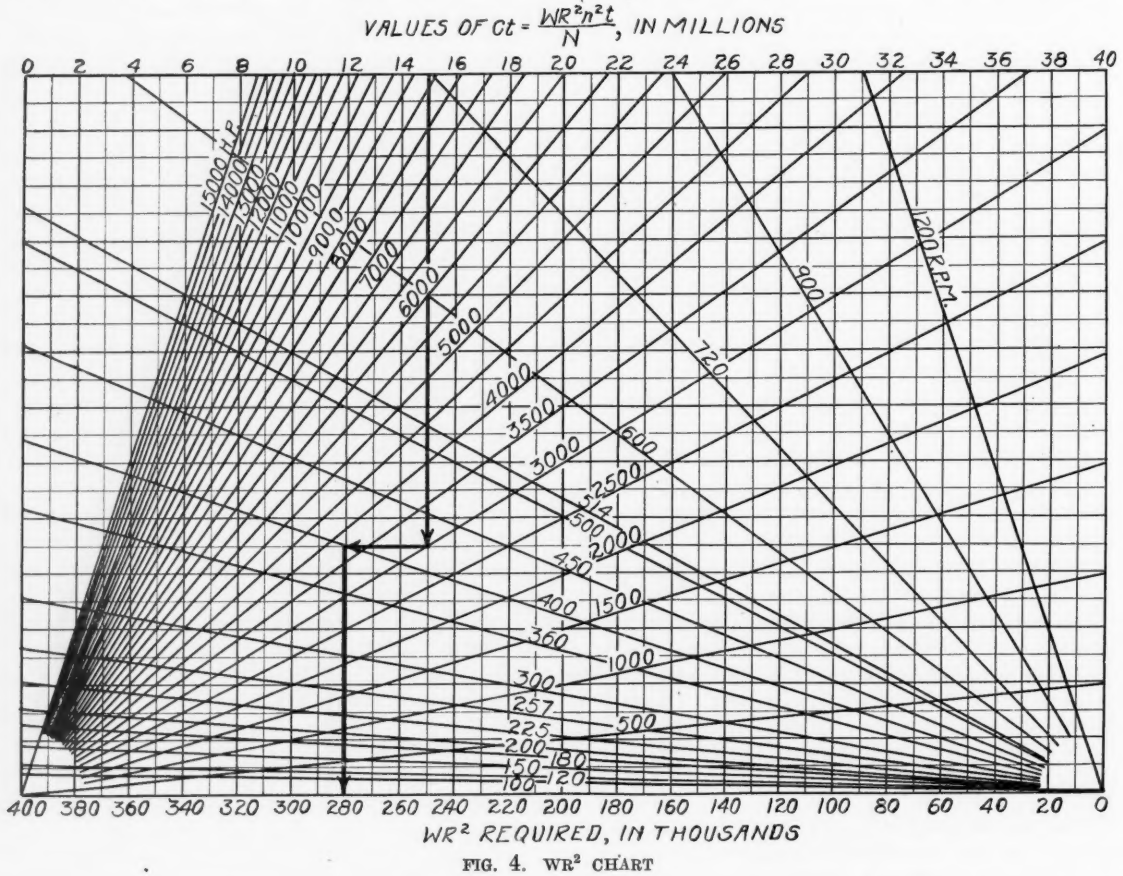


FIG. 4. WR² CHART

the governor closing the gates in such a manner that the rate of water cut off is slow at first and more rapid toward the end of the stroke. The relief valve will discharge water at a greater rate at the early part of the stroke than toward the end.

Let us now compute the WR^2 needed on the above basis and with a 25 per cent speed variation at full load; remembering that if the relief valve is made to discharge 85 per cent of the water, the velocity extinguished will be 15 per cent of 5.6, the full load velocity, and the power to be handled is 15 per cent of 1500 hp., supposing the turbine efficiency to be constant:

$$WR^2 = \frac{0.15 \times 1500 \times 6000 \times 0.15 \times 5.6 \times 5{,}000{,}000}{45 \times 600 \times 600 \times 25} = 14{,}000$$

With a generator WR^2 of 13,500, the remaining 500 can be made up in the runner. That small balance, only 3.6 per cent of the total, could safely be neglected. The speed variation table will be the same as before.

A chart showing the pressure rise for various pipeline lengths, velocities and closing times is shown in Fig. 3. The method of use is indicated on same. A WR^2 chart is given in Fig. 4, showing the flywheel effect required. In Fig. 5 a series of curves are given enabling the speed variations at 75, 50 and 25 per cent loads to be determined having full load variation given.

A New Type British Stoker

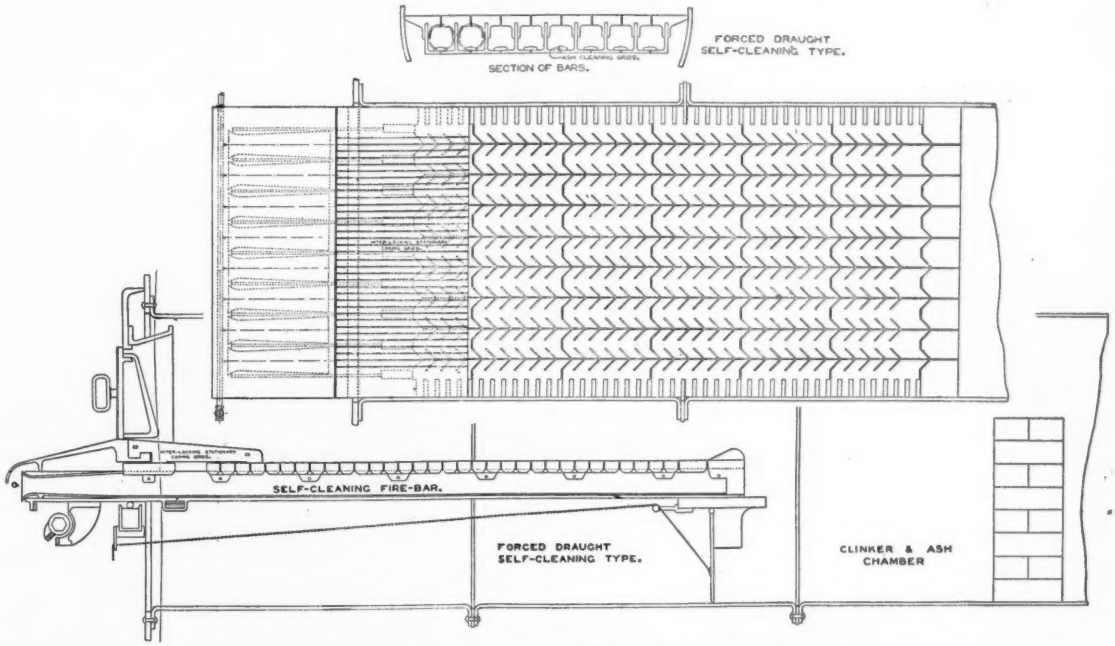
By C. H. S. Tupholme

A NEW type of furnace has been placed on the British market and is exciting considerable interest. This is the "Zenith" patent furnace, made by William Whittaker (Burnley) Ltd., of Burnley in Lancashire.

The furnace is built on an entirely new principle, the grate consisting of steel tees (4 in. by 4 in. by 3/8 in. section), placed close together side by side in the boiler flue, giving usually a grate length of 6 ft. The top portion of the grate consists of cast-iron fire bars (12 in. long by 4 in. wide) which are mounted on the stock or web of the steel tees, being held securely in position.

The air spaces of these fire bars are each about 2 in. long and arranged at an angle of 45 deg. and have 1/8 in. air space. The remaining width of the boiler flue is taken up by steel angles (which form the side bar), 4 in. deep and 2 in. wide, on which are mounted cast-iron fire bars, having pronged teeth cast on their side. These side bars are held securely in a stationary position.

At the end of each steel tee and angle is fitted what is termed the back block which seals up the end of the chamber or passage, the top surface of which is elevated and rounded off towards its end. These back blocks are held in position in the same manner as the fire bars and cannot rise up out of position through expansion or other causes.

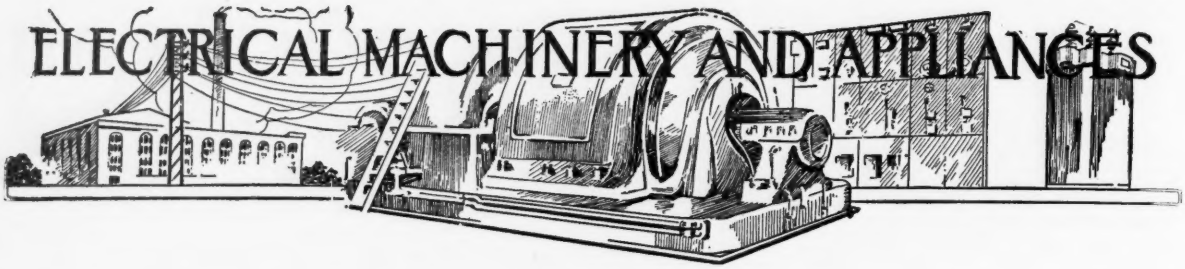


PLAN AND SIDE VIEW OF THE "ZENITH" PATENT FURNACE

When these bars are placed close together side by side in the boiler flue, air chambers or passages are formed. At the front of each chamber is fitted a trumpet shaped casting which is always stationary. Open steam jets are fitted in front of each trumpet opening, the superheated steam supplied to the jets forcing the air into the passage formed by the bars.

By this construction the air supply is split up into equal and separate divisions or compartments, resulting in each section of the fire having its own air supply, the air in one chamber not being able to escape into neighboring chambers.

The whole of the grate, including the supplies, and with the exception of the side bars, is reciprocated about 2¼ in. by cams 3 in. wide, slipped loosely on to a transverse hexagon steel shaft. These cams are so arranged that on the return movement no two bars move back side by side.



Ground Detecting Devices

THEIR THEORY OF OPERATION, CONSTRUCTION AND USE. BY VICTOR H. TODD

ONE OF the most important details in the operation of an electric system is to keep all lines free from accidental grounds. Of course, there are many cases where it is sometimes desirable to ground certain lines of the system such as the neutral of a three-wire system, or one leg of a transformer secondary in order to limit the voltage between any other wire and the ground; but where all wires are supposed to be thoroughly insulated some form of a continuous indicator must be employed to detect instantly the failure of insulation to ground.

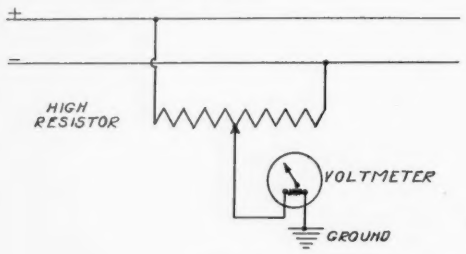


FIG. 1

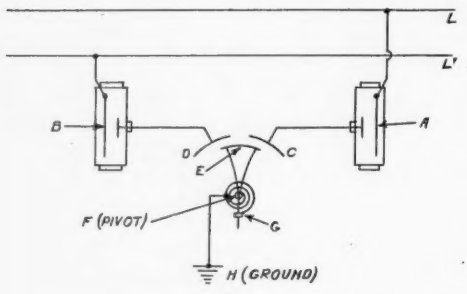


FIG. 3

FIG. 1. VOLTMETER CONNECTED TO INDICATE GROUNDS
FIG. 3. SCHEMATIC DIAGRAM OF SINGLE-PHASE GROUND DETECTOR

On simple low-voltage circuits, the use of ordinary incandescent lamps may be employed, or an ordinary zero-center voltmeter may be connected as in Fig. 1. There is a high resistor connected across the two lines, while the voltmeter is connected between a middle tap on the resistor and the ground. In the event of a ground on either line, the voltmeter will deflect to the right or the left, depending on the polarity of the line.

When the voltage used is in excess of 1000, the current consumed by lamps, or resistors and ordinary meters renders their use undesirable. It is then customary to employ some form of meter, in which the static attraction of the high potential charge is used to deflect a light movable vane.

Figure 2 shows a typical single-phase static ground detector for use on circuits of 2200 v. and more. Referring to the schematic diagram of parts in Fig. 3, the two vanes of the instrument C and D are connected to the two lines L and L' through condensers A and B. The function of the condensers is to insulate the instrument thoroughly from the high voltage line and at the same time allow a charge to form on the instrument vanes. They also prevent a short circuit should an accidental short be made between the vanes, or a vane to ground.

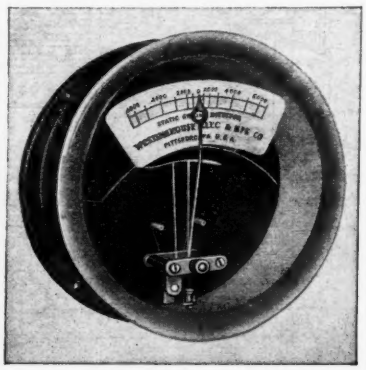


FIG. 2. TYPICAL SINGLE-PHASE STATIC GROUND DETECTOR

Movable vane E is pivoted at F and it is counterbalanced by weight G. Its motion is restrained both by gravity and by a light spiral spring which also serves to ground the vane, which would otherwise be insulated by the sapphire bearings in which the pivots rest. This vane and the case are thoroughly grounded.

Under normal condition, with both lines free from ground, there will be as much attraction between D and E as there is between C and E; consequently the pointer will show no deflection. But should an accidental ground occur on either line, it will decrease the charge on the vane and condenser connected to that line, thus allowing the opposite side to deflect the pointer away from the grounded side, the deflection being proportional to the extent of the decrease of insulation resistance on the grounded line. A ground on both lines cannot deflect the instrument, but this

constitutes a leak or short circuit which usually manifests itself in a violent manner.

Three-Phase Circuit

On a three-phase circuit, two single-phase meters may be used with either three or four condensers with the connection as in Fig. 4. If a ground occurs on the left-hand wire, then the left-hand meter will deflect toward the right. If a ground occurs on the middle wire, the left-hand meter deflects to the left while the

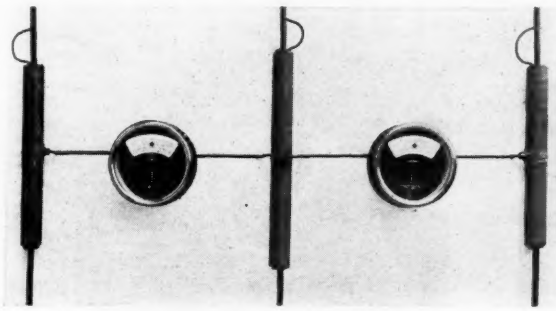


FIG. 4. TWO SINGLE-PHASE DETECTORS ON A THREE-PHASE CIRCUIT

right-hand meter deflects to the right. If the ground occurs on the right-hand wire, then the right-hand meter deflects to the left.

A single instrument designed especially for three-phase service is shown in Fig. 5, while the same instrument with one vane removed is shown in Fig. 6 and a schematic diagram of parts is shown in Fig. 7. There are three condensers, D, E and F, connected between the lines A, B and C and the stationary vanes G, H and I. The movable vane, J, is doubly pivoted on a universal joint so that it is free to move in any direction.

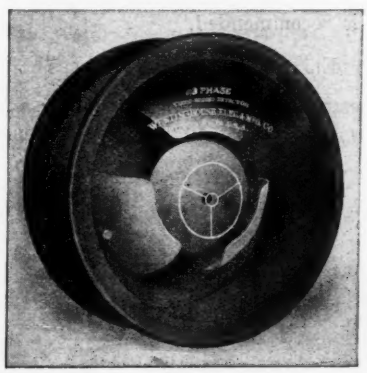


FIG. 5. THREE-PHASE GROUND DETECTOR

With all lines free from grounds, the attraction from all vanes will be equal and the movable vane will stay in a central position. But should a ground occur on any line then the vane to that line loses its attraction for the movable vane and thus allows the other two vanes to pull the moving vane under their influence, so that the black dot on the moving vane travels under one of the black lines painted on the glass.

These instruments are not affected by external magnetic nor electrostatic fields, and give indication on d.c. or a.c. of any wave form or commercial frequency.

There are two ways of mounting the condensers. One is to pass the line wire right through the hole in the condenser, using the wire as a support. This method cannot be used where the cable has a metal

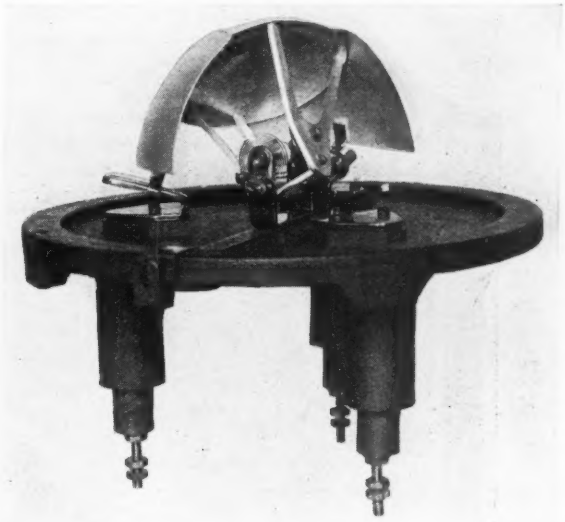


FIG. 6. THREE-PHASE DETECTOR WITH ONE VANE REMOVED

sheathing. In the other method the condenser is mounted on a separate insulator provided for this purpose.

Special leads are furnished for connecting the meter to the condenser and these must not only be thoroughly insulated from ground, but must be spaced exactly as specified by the manufacturer. These are usually 8- or 10-ft. leads spaced 6 in. apart. If necessary to use

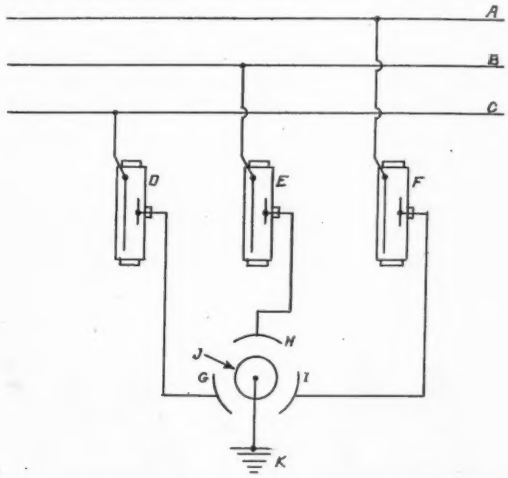


FIG. 7. DIAGRAMMATIC SCHEME OF 3-PHASE DETECTOR

other leads, then their length and spacing may be determined from the following formula:

$$d' = \frac{l'}{l}\,d$$

Where d = distance apart as specified.
l = length of lead specified.
l' = length required.
d' = distance apart required.

Leads should never be coiled up nor should they be installed in metal conduit.

Electrostatic Voltmeters

For high voltages, the electrostatic voltmeter has the advantages that it is easily insulated, does not contain a continuous metallic circuit, and consumes a negligible amount of operating power. These voltmeters operate on the previously described attraction principles, but are usually more delicately constructed and more accurately calibrated.

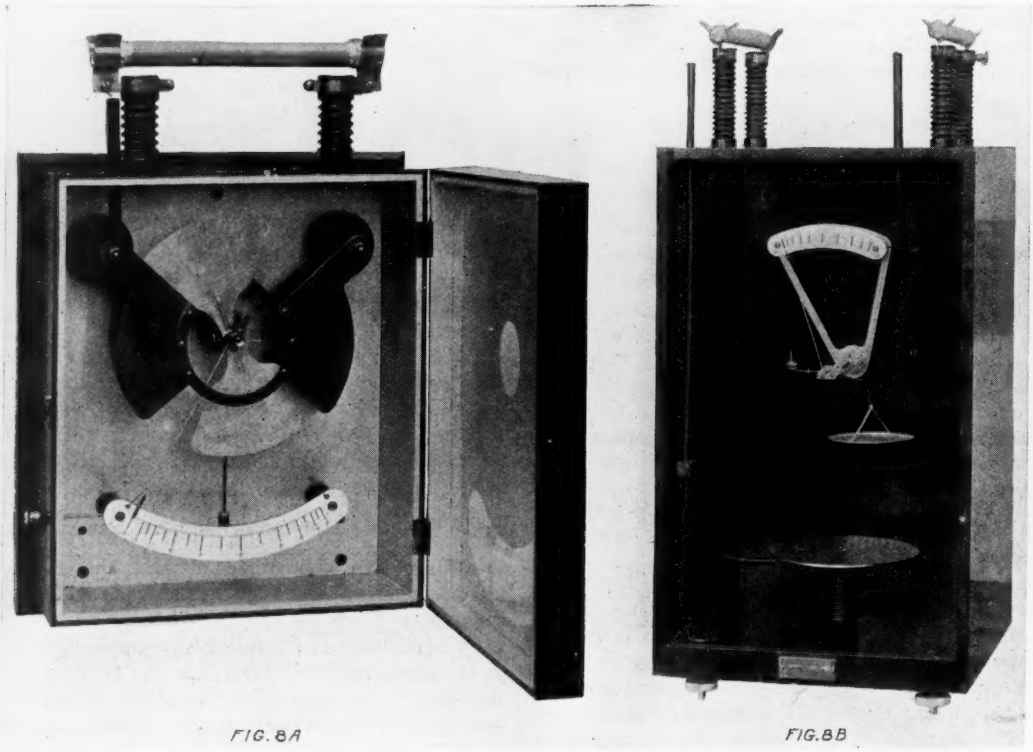


FIG. 8. TWO TYPICAL ELECTROSTATIC VOLTMETERS

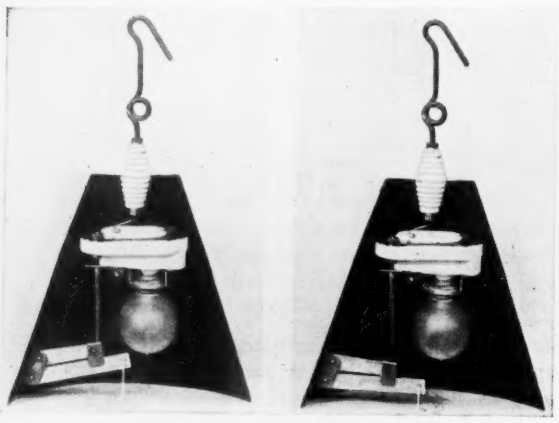


FIG. 9. POTENTIAL INDICATOR

Two high grade voltmeters are shown in Fig. 8; one is for the measurement of potential of the order of 3, 5, and 10 kv., while the other measures 20 to 50 kv. These meters are not provided with condensers, but are provided with suitable resistance to guard against accidental "shorts," causing damage. This limits the current and protects both system and instrument. The value of resistance supplied is about 100,000 ohms per kilovolt.

For the measurement of voltages above 50 kv., the sphere gap is recommended.

Electrostatic Glowmeters

The property of an exhausted tube or a tube filled with rare gas, to glow under the influence of high

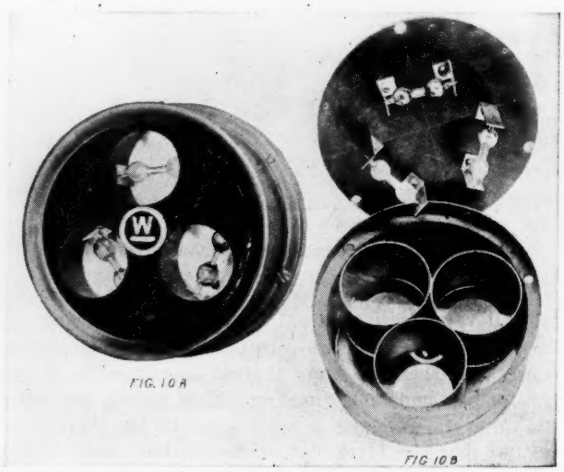


FIG. 10. EXTERIOR AND INTERIOR OF THREE-PHASE GLOWMETER

potential, has been known to experimenters for many years and has recently been commercialized to indicate potential, grounds and synchronism between three-phase circuits.

As a simple potential indicator, the bulb is mounted in a hood as shown in Fig. 9 and the whole indicator hooked over the line. The suspension indicator is weather-proof and is used for both indoor and outdoor service. As a rule, it hangs on the line continually, but can be moved about as desired. Sometimes the indicator is mounted on the top of the line switching pole and thus forms an easy indication of a live line.

Three-Phase Ground Detectors

For use as a ground detector, the glowmeter takes the form of Fig. 10 where external and internal views are shown. One side of each tube is connected to the

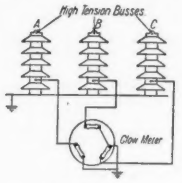


FIG. 11

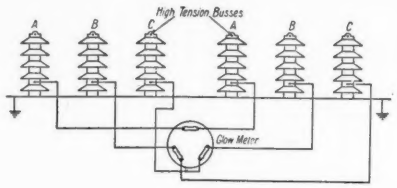


FIG. 12

FIG. 11. GLOWMETER CONNECTIONS; FOR USE AS GROUND DETECTOR

FIG. 12. THE GLOWMETER USED AS A SYNCHROSCOPE

lower part of a column insulator as shown in Fig. 11 and the other sides securely grounded. In operation with all lines free from grounds, each tube will give forth a vivid orange light but as soon as one line becomes grounded, then the tube connected to that line will go out, thus indicating the ground.

Synchronism Indicator

This same instrument may be used as a synchronism indicator and has the advantage that it may be connected directly to the lines thus eliminating all possible errors due to reversal of transformer connections, etc. The instrument may be mounted on a panel with switches if desired and with connections as shown in Fig. 12. It will be noted that one phase to the lower lamps is crossed, thus at synchronism the upper tube will be out while the lower two will burn dim. When the lines are not running in synchronism, there will be a lamp out at each succeeding variation in phase relation between the two circuits and this gives an apparent rotation, its apparent rotation depending on the difference in speed and whether the incoming line is running faster or slower than the bus.

Nursing a grouch in silence does not get you anything or anywhere. The best way is to speak up and get the thing off your mind.

Drying Out Large Transformers

By S. H. Abbott

ENGINEERS are frequently obliged to dry out high-voltage transformers when the only available method is by external heating. There are two ways by which this can be accomplished:

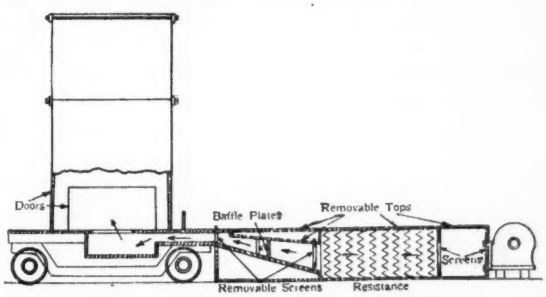
1—Drying the transformer assembled in its case.

2—Drying the transformer outside its case, and assembling it after it has been dried.

This article deals with an experience the writer had in France, in drying out a number of 6000-kv.a., single-phase, 10,000 to 70,000-v., oil-insulated, water-cooled transformers at two outdoor sub-stations.

The transformers in question had been en route from Pittsburgh, or outdoors in their packing cases at customer's station for 2 yr. Prior to the writer's arrival, the contractor had attempted to dry out these transformers by blowing hot air through a hole at one end of the packing case and an outlet at the other, with the transformers on their sides. He succeeded in burning out two transformers. The writer used successfully the second method mentioned above.

Each station has a small transformer house provided with a hoist for assembling and repairing the transformers. Each assembled transformer is furnished with wheel bases, by means of which it is pushed from its foundation onto a special truck, which is on a track leading into the transformer house. Two trucks were available at each station.



ARRANGEMENT OF APPARATUS FOR DRYING OUT LARGE TRANSFORMERS

A transformer core was removed from its packing case and the packing case bottom with its heavy timber was placed upon one of the trucks. In the center of this bottom, between the timbers, a square hole was cut. A wooden conduit was then built between the timbers, around three sides of the hole, and out to one end, where it connected with a large double wooden conduit, which extended into the box containing the resistance. At the end of the resistance box (which extended 2 ft. beyond the resistance) a motor-operated fan was placed, as shown in Fig. 1.

The transformer core was placed right side up, over the hole on the truck, and enclosed tightly in a wooden case. The case had four detachable sides held together by bolts as shown, so that it could easily be assembled and used for all transformers. The top of the case had holes to allow for the escape of air. Two doors were constructed at the bottom and one near the top of the case to allow for observation of temperature, etc.

The resistance used was "homemade," iron wire coiled into spirals and strung over spool insulators. Each unit (there was one unit at each station) consisted of three similar resistances, and each resistance was connected to a three-phase line through fuses and switches. One resistance was connected in delta, another in star and the other in uneven Z, so that, by opening switches or removing fuses, any degree of temperature could be secured. The total power used in this case was approximately 75 kw.

The wooden conduit connecting the resistance box to the conduit under the transformer was made double for conservation of heat. Removable covers were made to the double conduit and resistance box, in order that the interiors might be accessible. The resistance box and conduit were lined with asbestos, as far up as the transformer case. This reduced the fire risk and also kept the heat where it was most needed.

Common window screen, built into a frame, so that it could be removed for cleaning, was placed at the intake to the fan and at the entrance to the resistance box. Another window screen was constructed in a deep frame next to the resistance, on the fan side. This system compelled the air to pass through the center of the resistance, instead of around the edges, and thereby increased the uniformity of heat. A hinged door was placed at the intake to fan, which was raised and lowered to regulate the volume of air.

In the double conduit, as shown, were placed two screens of fine copper wire, in sliding frames. It was found necessary to remove and clean these screens, at least every other day. Otherwise, dust collecting on the screens would retard the air and cause a greater difference in temperature between the resistance and the transformer case.

At first, it was found that the temperature of the air entering the transformer case varied greatly at different points—to such an extent that the air at the hottest point would have to be dangerously hot in order to heat the coils sufficiently. To eliminate this condition, baffle-plates were arranged in the double conduit, as shown. Then at no place of entrance to the transformer case did the temperature of the air vary more than 1 or 2 deg. The temperature of the air entering the double conduit, of course, varied more—the hottest current being near the center of the entrance.

With the above system in operation, the following results were easily obtained with a fan of about 2000 cu. ft. per minute capacity. The average temperature of the air leaving the resistance was from 1 to 2 deg. higher than the air entering the transformer case, which was kept around 85 deg. C. The coil temperature was from 70 to 80 deg. C. The temperature of the coils at the top was not more than 2 deg. lower than the temperature at the bottom. The screens kept dust from entering the transformer and the heat was so well placed that the observers were obliged to have extra heat in the room to keep warm.

Wires were placed on insulators at the top of the transformer case and passed through holes in the top and connected to the windings and iron for testing purpose. Each transformer was dried out for about a month until the megohms resistance had attained a safe and constant value.—The Electric Journal.

Wiring a Switchboard

By John J. Ramsey

WIRING a switchboard at best means the handling of a lot of wire; sometimes there is a needless amount of wire used and the job is very unsightly when finished. The following is a plan I have used, the main object being to secure as neat and simple arrangement as possible of the wire, and if a little thought is taken the results will be satisfactory.

Instead of the usual method of supporting the bus bars overhead and then using so many wires from switch to bus bars and from bus bars to switch, use No. 00, or larger if the installation warrants it, slow-burning stranded weatherproof wire, in continuous lengths for each bus bar, as shown in Fig. 1. This can be attached to the switches by short bends at each end. For the intermediate switches, stubs of suitable length can be attached; by careful measuring of the distance between

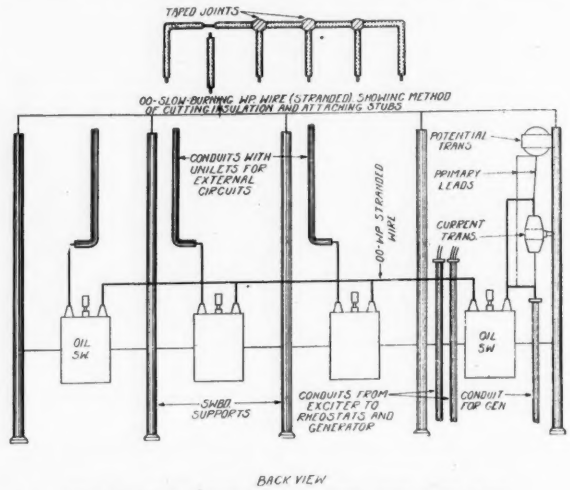


FIG. 1. STRANDED WIRE USED FOR BUS BAR

switches, these stubs can be attached so that the whole bar when made up will go right in place. In order properly to secure the stubs, cut away the insulation on the bar; also cut away the insulation on the end of the stub, then untwist the wires on end of stub and clip off part of them, untwist or pry apart the wires on the bar where the stub is to be attached and push the wire left on the stub through these wires, bend down in a neat manner and solder firmly, then tape. If a little care is taken, these stubs can be securely attached and taped over without leaving an unsightly joint.

Of course the insulation must be trimmed away on the end where the lugs attach, and I have found the most satisfactory way of soldering these lugs as follows: take a small ladle and clamp the handle in the vise so that the flame from the blow torch reaches it nicely; put in enough solder to make a bath for the lugs. When the solder is well melted, throw in some of the lugs, but first treat the lugs with a good soldering flux. Some people prefer one kind and some another. I prefer the solution made up of saturated zinc chloride, alchohol and glycerine. These lugs will become well tinned, and, also tin the stubs by holding them in the molten solder. Use an old pair of pliers or tongs to pick up the lugs, dipping full of solder when taking them

out of the ladle, then insert the stubs and cool by using a bunch of waste dipped in cold water. This makes a good job and then the lugs can be twisted around until they line properly with the holes in the switch terminals. These busses are not very high above the switches; they do not need to be.

To take care of the outgoing wires from switch to the point where they leave the building, use suitable sized conduit with inlets and pick up the feeder wires back of the board near the switch. Run a conduit for each set of feeder wires and support the conduits as shown in Fig. 2 (end view) by placing 1 by 4-in. across the top anchor rods of switchboard framing irons. Fasten these boards to the rods with U bolts and fasten the conduit to boards with loops or equivalent. Use brackets for supporting instrument transformers and attach them to the switchboard supporting posts, also shown in Fig. 2.

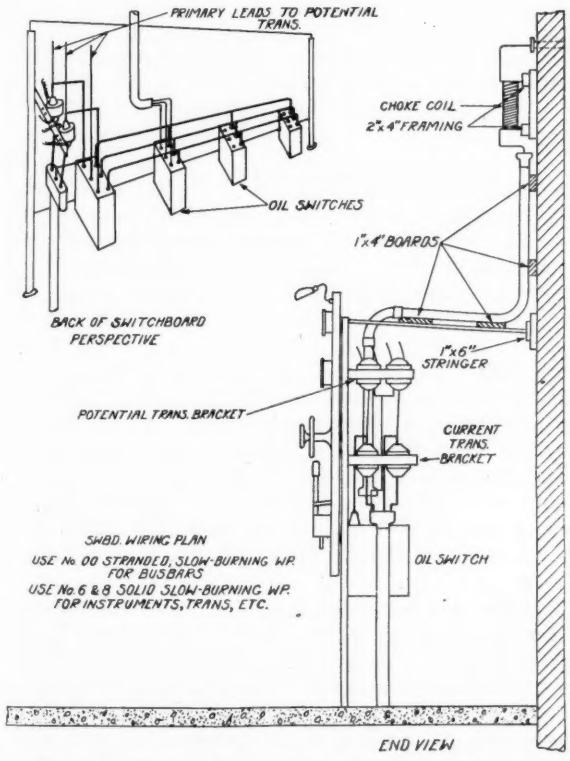


FIG. 2. BACK AND END VIEWS OF SWITCHBOARD SHOWING WIRES ENTERING CONDUIT

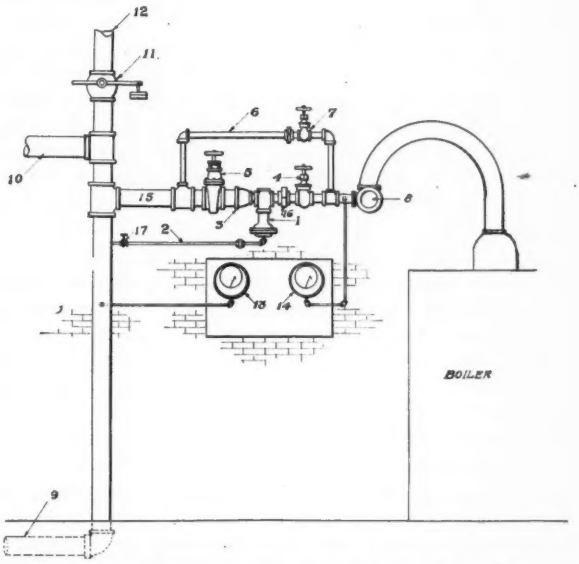
This arrangement will leave plenty of room behind the board and no wires run around in an unsightly way. This also permits the board, where necessary, to be placed closer to the wall, and still give more room than is usually found behind switchboards.

Use conduit for all runs from board to generators, exciters, street light transformers, etc., and do not make the mistake of using conduit too small, or, what is more serious, using too small wire from exciter to board and from board to generator. Always note the amperage on exciter plate, then calculate the distance and allow for the "drop in voltage," but be sure not to allow for very much; better have the wire too large than too small. Always remember, in running wire in conduit for alternating current, that all the wire for each circuit must be in one conduit. I have also noticed that a common mistake is to place the lightning arresters between the choke coil and bus bars, when the choke coil should be between the lightning arresters and bus bars. Also the discharge resistance is not always properly connected in and sometimes not connected at all in the exciter circuits; this is a matter that should not be overlooked. True, a plant might operate for years and mothing happen if this was not connected, but it is taking an unnecessary chance. Good, well installed, liberal capacity protective devices will always pay for themselves in satisfactory continuous uninterrupted service.

Installing a Reducing Valve

By C. H. Fuller

THE following arrangement has been proven very satisfactory for low-pressure heating plants where exhaust steam is available during the daytime and an auxiliary supply of live steam is required for the heating plant during the night.



REDUCING VALVE CONNECTED UP WITH PROPER SIZE PIPING

When a reducer is installed as shown in the drawing, a minimum supply of steam will give the desired results. The high-pressure steam is taken from the main header, near the boilers in the usual way and carried through a pipe of adequate size to supply the requirements of the heating system.

Reducing valve No. 1 should be of the same size as the live steam pipe; globe valve No. 4 will also be of this size. After passing through reducing valve No. 1, an increaser should be connected directly adjacent to the reducer by a close nipple. The large end of this increaser should be of the same size as pipe No. 10. (Pipe No. 10 is the low-pressure main supplying the heating system.) Pipe No. 15 leading from the increaser to the exhaust pipe No. 9 from engine will of course be of the same size as pipe No. 10. Number 12 is the outboard exhaust line discharging to atmosphere.

In case it becomes necessary to remove the pressure

reducer for repairs, the gate valve No. 5 on the low-pressure side and the globe valve No. 4 on the high-pressure side can be shut, disconnect the union No. 16 and remove the reducer. (The small valve No. 17 on the equalizer line will necessarily be closed too.)

The bypass No. 6 is installed for such an emergency and by opening the globe valve No. 7 on this bypass an adequate supply of live steam will be available during the time the reducer is out of service. This bypass should be one-half the size of the live steam or high pressure pipe leading to the reducer.

A recording pressure gage No. 13 should be installed, connected to the exhaust main to serve as a guide in adjusting the reducer and the back pressure valve No. 11. A similar gage No. 14 will be connected in such a way as to give the boiler pressure.

The two important points the writer has endeavored to make clear are:

(1) Be sure to increase the size of your low-pressure main to its maximum size directly adjacent to the reducing valve and thus gain the desired expansion chamber for the low-pressure steam which at the same time will allow the reducer to discharge an adequate amount of steam at lower pressure and ultimately reduce the cost of operation.

(2) The bypass No. 6 which eliminates the necessity for allowing the heating system to become cold at any time.

Hoisting and Conveying*

Machinery Safeguards and Safe Operation. By the Engineering Department of the National Safety Council

MISUNDERSTANDING of signals is one of the greatest causes of accidents on all kinds of hoisting apparatus. The fact that a signal may be misunderstood is one strong reason against permitting men to ride on hoists. Whistle signals are liable to be confused with other noises, and are not recommended. Hand signals are satisfactory where the engineer can always easily see the signalman. A mechanical bell at the engine, operated by pulling a wire, is fairly satisfactory, if the wire does not have to be too long nor run around corners; only wire of ample strength should be used and it should be carefully protected against fouling, by being enclosed in a pipe or otherwise guarded where exposed to injury. Because of the hazards connected with whistle, hand, or mechanical bell signals, many construction men recommend the use of an electrical bell, or in some cases, a telephone. Where the engineer cannot see the hoist, it is advisable to mark the cable to indicate the position of the hoist at every landing. This affords a check on the signal system and reduces the chances of accident due to a misunderstanding of signals.

It is essential that brakes be absolutely reliable because of the hazard to the building and to workmen should any part of the apparatus fall. Brakes should be tested frequently and inspected daily to make sure that they are always in condition to hold the maximum load, and a dog or pawl should be provided to hold the load when it is to be suspended for any considerable time, as the brake should not be depended upon for this purpose.

The cable should be securely fastened to the drum either by zinc plugs or by suitable clamps and at least two full turns of the cable should remain on the winding drum at all times.

The operator or hoisting engineer has great responsibility in the handling of a hoist or derrick and should be a man thoroughly familiar with the apparatus and reliable in every respect. No person given to chance-taking, or inclined to let his attention be drawn from the work, should ever be permitted to operate hoisting apparatus.

A careful inspection should be regularly made of all bolted and nailed joints, hoisting cables and guy wires and their fastenings, platforms, railings, and toe boards. The hoisting engineer is probably the best man to make this inspection if he has the time; if not, somebody else should be instructed to make such inspection at regular intervals.

* Continued from page 914, Sept. 15 issue.

Platform Elevators

Platform elevators used for hoisting brick and other materials in wheelbarrows or trucks present many of the hazards of permanent freight elevators. If the elevator is located inside the building, the opening at each floor should be guarded with a railing and toe board. A solid, slatted, or wire mesh enclosure 6 ft. high (some laws require 8 ft.) is better. On the open side, a bar gate at least should be provided to prevent the watchman or other person from walking into the opening when the elevator is not in use. It is best to place bar gates 2 ft. from the openings. A wooden or heavy wire mesh cover over the top of the car is advisable to protect men loading the car at the bottom from being struck by objects which may fall from the upper floors.

If men are permitted to ride on the elevator, many other safeguards, such as are found on permanent freight elevators, should be provided. As these safeguards are practically never provided on construction hoists, men should be positively forbidden to ride on them and to make this rule effective, it should be scrupulously obeyed by the superintendents and foremen themselves.

Derricks

Under no condition should workmen be permitted to ride on loads being handled by derricks or on sling chains.

It is of vital importance that derricks rest on good foundation and be securely braced to prevent slipping. Great care should be taken to anchor the foot of the mast securely as there is a constant tendency for it to be pushed out of place, especially when the boom is near the horizontal. The top of the mast should also be securely held in place by guy-wires. At the end of the day or shift, or when work is stopped for a length of time, the boom should be lowered to the horizontal position or else raised to the vertical position so that there is no danger of its swinging in the wind or being meddled with by unauthorized persons.

The foundation of derricks should be inspected at frequent intervals to make sure that everything is in perfect working order and that the foot of the mast is not slipping. Wooden masts and booms should be frequently inspected for evidence of decay and rot. Sheave pins in the blocks should be frequently inspected because these are under heavy load and are apt to became badly worn within a short time. All pulley and sheave pins should be lubricated at regular and frequent intervals, the gudgeon pin and foot bearing should also be oiled occasionally.

A special hazard is introduced if the boom is longer than the mast, because when hoisting is being done with the boom near the vertical position the boom fall tends to pull the top goose-neck of a stiff-leg derrick or the spider of a guyed derrick off the gudgeon pin. If the mast is of wood, a cotter pin should not be depended upon to hold the goose-neck or spider in place, because of the comparatively low shearing resistance of wood with the grain. Strong holding down guys or shrouds should be installed to hold the goose-neck or the spider at the top of the mast securely in place.

On construction work the importance of making sling hitches properly can hardly be overestimated. On high buildings, especially in thickly populated cities, should a sling break or the load became unhitched, serious results are almost sure to follow. Because so much depends upon the condition of slings used for such purposes, particular care should be exercised in their selection and use. They should be inspected frequently and not permitted to lie about, but should be kept in order in a proper place.

A hold-back line or guide rope is advisable on all loads that are liable to swing while being hoisted. This is especially necessary when hoisting unwieldy pieces, such as long beams. Hold-back lines should be held by intelligent workmen who should be under command of the chief hitcher.

Conveyor Safeguards

While mechanical conveyors have proved useful as time-saving and labor-saving equipment for handling material of almost every kind, there are certain inherent hazards and care should be taken to see that the following general precautions are heeded.

No adjustments or repairs should ever be made while a conveyor is in motion. It is also advisable that all oiling of conveyor equipment be done while the machinery is standing still, unless it may be done without requiring the oiler to come within dangerous proximity to moving parts.

Many accidents have been caused by starting conveyors without first giving warning to men who may be making repairs or adjustments, or oiling the machinery. With such equipment, as with other types of power-driven machinery, every repair man should be provided with a lock or a warning sign which he should put on the starting lever or operating switch of the driving machine whenever he is doing work on the conveyor. A rule forbidding anyone to remove a lock or a warning sign, except the person who placed it, should be enforced.

Enclosures

Power-driven conveyor equipment should be guarded with an enclosure or substantial railing wherever persons might come into contact with it. Workmen should be forbidden to cross over exposed conveyors except at regular crosspoints, where there should be an elevated bridge or a tunnel so that there is no danger of any person coming in contact with the conveying equipment.

At points where conveyors pass from one floor to another and are not entirely enclosed, the opening through the floors should be protected by railings and toe boards. Wherever conveyors cross over passageways, aisleways, or places where employes are at work or must pass beneath them, screens should be provided to catch material which may fall from the conveyor.

All belts, pulleys, chain, and rope drives of conveyor equipment whenever located within 7 ft. of the floor or working level should be effectively safeguarded. All gears should be completely protected by safeguards; all set screws should be of the countersunk type; sprocket wheels and chains should be properly enclosed. Projecting ends of shafting should be guarded or else cut off.

There is often found a tendency on the part of some workmen, especially boys, to ride on conveyors. Such a practice is decidedly dangerous and should be strictly prohibited.

Control Devices

For all power-driven conveyors devices should be installed at frequent and convenient places for stopping the conveyor machinery in case of an accident. Such devices should always be provided at loading and unloading stations, and at drive and takeup ends. Where a series of conveyors is used to transport material through a plant, it is necessary that the stopping devices be so arranged that when one is stopped, all conveyors ahead will also be stopped, in order to prevent the dumping of material on a standing conveyor.

In plants where conveying equipment is extensively used, it is suggested that a competent employe be delegated for regular and frequent inspection of all the equipment to make sure that it is in proper working order and kept well lubricated. Whenever any broken, defective, or badly worn parts are discovered immediate repairs should be made and the equipment should not be continued in service in an unsafe condition.

Loading and Unloading

Rubber matting or other antislip floor covering at the loading and discharging stations is suggested so that the workman will have a sure and safe footing. Floors should be kept free of material which may be spilled from the conveyors. Alongside elevator conveyors it is well to provide a substantial runway, with standard railings and toe boards.

Where material is loaded by hand, the speed of the conveyor should be such that workmen will have ample time to place the material in position so that it will not project over the sides of the conveyor or be likely to fall. For loading grain and such material, feeding devices are sometimes used and with them the conveyors may be run at a higher speed. Wherever feeding devices are used the workmen do not have to place the loads directly upon the main conveyors and thus are not exposed to as great danger.

The removal of material from conveyors except at regular receiving stations should be forbidden. This is

of particular importance whenever articles such as heavy boxes, barrels, and bags are being transported. Workmen should not be permitted to stand on the supporting frames of conveyors while loading or removing articles because, should their feet slip onto the moving conveyor, they are likely to receive serious injuries.

Gravity Conveyors

Gravity conveyors, as the name implies, are those which require no mechanical power, but depend wholly upon the force of gravity for their operations. They may be divided into two general classes; chute conveyors and roller conveyors.

The hazard in the use of spiral chutes is not great. Any such equipment should, of course, be substantially constructed, well supported, and carefully designed for handling material of the size and character for which it is intended. In removing material from the delivery end of spiral chutes, accidents frequently occur when a workman's hand becomes caught by descending material and mashed against other material which is on the delivery table. Where the chute is enclosed it is suggested that a warning sign be placed over the delivery end of the chute to warn against this hazard. Some simple device, mechanically or electrically operated, to give warning that a package is about to be delivered from the chute is advisable, especially where the packages cannot be plainly seen in descent.

Spiral chutes introduce a very important fire hazard because they form a flue from lower floors to upper floors which will serve to spread a fire quickly. Two methods of eliminating this fire hazard are in use: One, is to enclose the chute in a tower of steel, concrete, or masonry; the other, is to provide fire doors (draft checks) where the chute passes through floors.

The enclosed tower type has doors at each charging station, and also a door at the delivery end. The charging station doors should be kept closed, except when charging is being done. The door at the delivery end should close automatically in case of fire.

The open type of chute may be made entirely safe against the spread of fire if shutoff doors (draft checks) are installed wherever the chute passes through floors. These doors are of two kinds—the vertical sliding and the shutter types. Both types should be arranged, by means of fusible links, to close automatically in case of fire.

Where the open type of chute is used a guard railing and toe board should be provided at each floor to protect the workmen who might stumble into it. The charging stations should preferably be guarded either by a movable railing or by a hinged door or gate.

In the use of roller conveyor equipment the principal hazard is that of material running off the edge of the rollway and falling to the floor. A guide, or guard railing, is sometimes provided on each side of roller conveyor ways, to guide the material and prevent it from running off. Such guard rails are especially advisable at corners and turns, and on elevated conveyors where men must work or pass beneath. Workmen should be warned always to place material carefully on the conveyors, so that it will ride safely.

Belt Conveyors

It is important that the driving mechanism of belt conveyors be properly safeguarded. The conveyor belt and trough should also be railed off or otherwise protected so that workmen will not attempt to cross over or ride upon it.

Loading hoppers are ordinarily supplied as a part of belt conveying systems used for handling grain, cement, fertilizer, crushed rock and ore, coal, etc. By the use of loading hoppers, there is less wear on the belt because the material is fed gradually over a space of several feet of the belt. Loading into the hoppers is also less hazardous to the workmen because there is little danger of the material being thrown out by the moving belt. Where movable hoppers are used, care should be taken that the hoppers are securely and rigidly fastened in place so that there is no danger of any part of them coming in contact with the belt and an accident resulting.

Trippers or automatic discharging stations are frequently used with belt conveying equipment, to empty the belt of its load at the desired location. Workmen should be cautioned to use care in dislodging material which may become choked up in the chute of a tripper, and to keep away from moving parts.

Great care must be used in manipulating a self-propelled tripper because should the propelling mechanism be thrown into gear there is a possibility, unless the operator is attentive to the work in hand, that it will run to the end of runway or belt and cause an accident. A device for throwing the propelling mechanism into neutral position should be provided at each end of runway.

Care should be taken that the working tension in a belt is not too great. This should not exceed 24 lb. per in. per ply which is approximately 1/16 of the breaking strain of a belt. For temporary installations 36 lb. per in. per ply may be used, but this is the extreme limit at which conveyor belts should be operated.

Chain Conveyors

Chain conveyors are made in various types and to serve various purposes. Frequently, hooks are attached to the chain links and from the hooks the material is suspended. In another type the chain runs in the bottom of a trough and has attached to it at intervals lugs which serve to pull the material along in the trough. The return portion of chain or cables should be effectively guarded against contact.

Where the conveyors are in continual operation, as is ordinarily the case with log haul-ups from water-runs, the conveyor should be railed off so that workmen cannot step upon it. Where it is necessary that workmen at times step upon the conveyor to load the material, the operator of the conveyor should always be in a position so that he can see the entire length of the conveyor. Under no conditions should he ever start the conveyor when a man is on it or until he has sounded a gong warning that it is to be started.

Flight conveyors are in fact an adaptation of the chain conveyor, consisting essentially of a chain to which at regular intervals are attached scrapers, or flights which are pulled through the conveyor trough (usually of metal). The precautions in their use are the same as with ordinary chain conveying equipment.

Bucket Conveyors and Elevators

These consist of a chain to which are attached at regular intervals, buckets for hoisting and conveying the

material to be handled. They are commonly used for coal handling equipment in stone-crushing plants, and the like, and present approximately the same features in their use as the belt and flight conveyor. Where bucket elevators are enclosed as in flour mills, grain elevators, and cement plants it is customary to provide removable sections (doors) in the enclosure for inspection purposes. No attempt should ever be made to remove material from the buckets at these inspection doors while the elevator is running.

For emptying the buckets at any desired location, tripping devices are provided. These are so placed that they will trip the bucket and empty its contents wherever desired. It is best that the control mechanism for shifting and locking the trippers be so arranged that it may be operated from a place of safety so that workmen will not need go on the conveyor-way to change the position of the tripper.

Where the conveyors hoist the material and carry it along over stokers or bins, it is advisable to provide a permanent foot-walk alongside the conveyor for the safety and convenience of repairmen and operators.

A bucket elevator or an inclined conveyor operating under a load will, unless a safety stop is provided, reverse and carry the material to the loading point if the power is suddenly cut off. Such an occurrence will undoubtedly cause much annoyance and may result in serious damage to the equipment or injury to persons. Every bucket elevator or conveyor should be provided with a mechanical device which will prevent the machinery running backward.

Apron Conveyors

Apron or slat conveyors consist of two strands of link belt or chains to which plates or strips are attached so as to form a continuous surface. The apron or slat conveyor or carrier is particularly suited for hauling abrasive materials such as steel billets, foundry flasks, heavy boxes and cases, freight packages, trunks, etc.

Belt, flight, and apron conveyors are sometimes made in portable motor-driven units mounted on wheels or suspended from trolley track and moved from one location to another in a plant, and require the same care as with the stationary type. The feed circuit should be armored cable, and all live electrical parts should be properly enclosed.

Screw Conveyors

The principal danger in the operation of spiral screw conveyors is that of the workmen getting their hands or feet caught in the conveyor. Never under any condition should an attempt be made to loosen material in a screw conveyor trough without first shutting off the power, nor should any attempt be made to repair conveyor troughs while the conveyor is in operation. It is suggested that a warning sign "SHUT OFF POWER BEFORE LOOSENING MATERIAL," be placed over openings in conveyor troughs.

All conveyor troughs should be completely covered. The covers are ordinarily made in removable sections for purpose of inspection and convenience in dislodging choked material. One member of the National Safety Council has taken the precaution to provide double covers for its conveyor troughs. A second cover made of heavy wire mesh is placed underneath the solid top. This wire mesh cover is made in removable sections corresponding in size to the top cover sections. The screen covering underneath will permit of inspection and still guard the screw, but may be removed when necessary.

Frequently the charging doors to screw conveyor troughs are not properly guarded, and a workman may carelessly step into them and be injured. In every case the charging stations should be grated over with a substantial grating, or else properly boxed into a sufficient height so that workmen cannot step into them.

The driving gears at the end of conveyor troughs should be entirely enclosed.

Aerial Cableways

Aerial cableways are frequently used on large construction jobs, such as irrigation dams, for conveying concrete, rock and other materials. They are used also to some extent for coal and ore handling equipment. The principal hazards in their use are falling material, injury to workmen inspecting and oiling the cables and carriage, and misunderstanding of signals.

No attempt should be made to carry on work directly underneath the tramway, except, of course, at the loading and unloading stations where exceptional precaution should be taken. Wherever it is necessary for workmen to pass frequently underneath the tramway, it is suggested that a covered passageway be provided.

The equipment should be regularly and frequently inspected with special attention to the sheave wheels and bearings, the cable fastenings, the bucket latch and trunnions, and all load-sustaining parts. All cables should be kept well oiled both for the purpose of lubrication and for protection against the weather.

It is of much importance that a dependable and sure method of signalling be used wherever men must work at the loading or unloading stations. A telephone or electric push-button system is advisable.

New Corporation Formed

What it is said will be the largest machine shop, foundry and boiler works west of Chicago is to be erected in Denver, Colo., articles of incorporation having been signed and work to start at once.

The signatories are: T. B. Stearns, president of the Stearns-Roger Manufacturing Co.; T. A. Dickson, vice-president and general manager of the Colorado Iron Works; Frank Shepard, president of the Denver Engineering Works, and Albert Cordingly, president of the Queen City Foundry Co., all of Denver, Colo.

The stock is all common, in 10,000 shares, at $100 each, and the life of the corporation is 20 yr.

In commenting upon the project, R. W. Gordon, general manager of the Stearns-Roger Co., and treasurer of the new corporation, said: "The purpose of the consolidation is to cut down overhead expenses and boost production to a point where Colorado firms can compete with eastern manufacturers on a scale never before attempted in the west. The new arrangement will obviate the necessity of sending large amounts of orders east for making. Hereafter they will be turned out right here in Denver."

The new concern will be known as The General Iron Works.

J. B. Dillon.

The Harmonics of the Power Plant

THE AROMA, COLOR SCHEME, HARMONICS FURNISH A VALUABLE INDICATION OF THE CONDITION OF A HOTEL POWER PLANT. BY GEORGE TALCOTT INGERSOLL

NOT MORE than a few years ago, a dairy barn was a place of many rank odors, but the farmers with the help of the agricultural colleges and experiment stations have found a way to change all that and today the aroma of the modern dairy barn is sweet and clean as are also the products which are turned out. And, similarly, our hotel power plants can be just as sweet and clean.

If we go into a fertilizer factory or a gas works, we encounter certain odors and smells which are a part of and peculiar to the business. If we go into the kitchen of a large hotel, we meet a variety of odors; it may be soup, fried bacon, roast turkey, beefsteak, vegetables, coffee; all these odors are a part of and the result of the various cooking operations; but sometimes there comes a peculiar rank odor; something is burning and requires prompt attention. It is a warning.

So in the hotel power plant there may be many smells and odors such as poisonous sewer gas coming from the sump; ammonia leaks from the refrigerating system; gases from the boiler furnaces; the peculiar odor that sometimes comes from a commutator that has never been trued up; the smell of a hot bearing; the smell of dirty, greasy floors and old waste; and too often through open windows from the alleys a variety of other odors is added to the mixture. Some of these are warnings, as they tell plainly that something is wrong and needs attention. Perhaps the manager believes that such odors are a necessary part of the plant and cannot be cured, and this may be the reason why his visits to the power plant are few and brief; but there is a way to cure these unpleasant things, and when the chief and his assistants get busy in this new service work to reduce unnecessary waste and loss, they will find that as the waste and loss are reduced the bad odors will vanish.

Thus the aroma of the power plant gives an interesting and true guide to the overall efficiency of the plant.

THE COLOR SCHEME

AS THE MODERN hotel has a network of piping for various purposes throughout the building, a properly worked out color scheme is of much value; it makes for utility, simplicity and efficiency; and is a graphic chart, on a large scale, that shows at a glance the use of any particular pipe. It is of use and benefit to any power plant man, especially the new man, and it may be the means of preventing serious mistakes and accidents. It adds to the general appearance of the power plant rooms. It promotes order and system and cleanliness. It blends with the harmony and aroma of a high class power plant. Its general effect is artistic, pleasing, elevating.

No part of the color scheme is so important as the lighting. It affects every guest and every employe. Light costs money, as it takes current. The hygienic and efficient lighting of hotels and similar buildings is an art and science which has made great advance in the past few years, and there are engineers and manufacturers who specialize on hotel work. There are losses in the lighting scheme of many hotels which could be stopped at a moderate expense.

The color scheme or its absence in a hotel power plant therefore gives an interesting and valuable guide and clue to the overall efficiency of the plant.

THE HARMONICS OF THE POWER PLANT

IN THE PAST few years we have learned many important things about that world which is all about us but which we cannot see with the human eye. Recently men of the highest skill, knowledge and experience in various branches of science were called upon for special research work. What those men did, what they found out, is not yet written in text-books and may not be so written for some time. The reason for this is that science deals with facts or things that can be proved and demonstrated, not only once, but many times and by many investigators, which takes time. It must be this way, for science must have a stable foundation and gradually build up a structure that will be in harmony with nature's laws.

At the same time, it is a good thing for every individual to do his own thinking and try to keep up with progress. May we not then say that life or activity in the form of intense vibration is everywhere and there is no dead or inert thing in nature, for this mysterious unseen force or activity permeates everything? A few illustrations may be given: Wireless telegraphy is one example. Radium, which is extracted from minerals, is another. The minerals are alive and their life or activity has been observed in the laboratories. In the same sense every machine is alive; for example, the generator, or the motor, in fact, every machine and piece of equipment in the hotel power plant; there is, however, a difference and a wide variation in the rate of vibration. Each machine emits its particular note or tone, when it is running, and some men's ears are sensitive to these notes or tones. Many an expert automobile man can tell by the sound whether or not his machine is in tune. Many a locomotive engineer is sensitive to the notes and tones of his engine and knows quickly when anything is wrong. An expert watchmaker will hold the movement or works of the watch to his ear, for the notes and sounds quickly tell him what is wrong or out of tune. The piano is another simple illustration. It produces a number of different notes; certain of these notes sounded at the same time give harmony, others sounded at the same time give discord. Every piece of equipment in a hotel power plant has a rate of vibration and when running emits its own characteristic note to which some men are sensitive while others are not, just as some men can tell the difference between harmony and discord on the piano and others cannot.

To illustrate a little farther: Go with me about seven in the evening to the main dining room of the large modern hotel and listen for a few moments to the harmony of the symphony orchestra. The leader or director of this orchestra must be a musician, an artist and a designer. He is probably a designer or composer

of music and can play many different instruments. In selecting the various members of his orchestra and the various instruments to be played, he will use all his art, skill and knowledge to secure a combination of both instruments and players who will respond to his ideal of harmony.

Now go with me to the inner works or power plant of a hotel. The chief engineer is the director or leader, his assistants are the players. The various machines are the instruments. Mr. Hotel Manager, is your power plant orchestra playing harmony or discord? If there is serious discord, is the trouble with the director, the players, the instruments, or all three? It is a most interesting problem and may be more extensive than would appear at first thought.

Thus the harmonics of the power plant give a most interesting and valuable clue and guide to the overall efficiency of the plant.

The Value of Recording Instruments

"Where ignorance is bliss, 'tis folly to be wise," is not always a safe rule to follow; at least it will not apply to hotel power plants where the manager and the power plant men want to help to reduce waste and loss. A graphic recording instrument is a witness of the work being done by some particular machine and it plays an important part in locating waste and loss. There has been an amusing story going the rounds about the negro under trial for midnight chicken stealing. The judge took a hand after the closing of all testimony on the part of the State and asked the negro if he had any witnesses, to which the black man replied: "Jedge, I spec' I'se a little peculiah—when I goes out for chickens I never takes no witnesses."

I fear there are some hotels where there are frequent shut-downs, elevators out of commission, water shut off and many other troubles where the manager and the chief engineer do not want any witnesses. They know in a general way that power plant expenses each month are much higher than they used to be, but room rates are high and business is good and so they let things go and do not take the trouble to find out about unnecessary waste and loss. They have no witnesses and don't want any. In the power plant of such a hotel will be found a few cheap pressure gages for steam, air, water, ammonia, brine, some cheap thermometers, a switchboard almost devoid of instruments except the graphic recording instrument put there by the power company.

Who would purchase a high grade automobile with no instrument board and no instruments? Suppose the salesman did argue that the machine would run just as well without instruments, and that they were a useless expense; such a salesman would never make a sale for nobody would buy the car without a complete instrument equipment.

In the chief engineer's office of large modern passenger steamships are complete instrument boards showing the working of all machinery and equipment. No passenger steamers would be permitted to run without such instruments. The passenger steamer is really a hotel afloat.

Too many modern hotels are running without complete sets of graphic recording instruments. It is of great importance to the successful hotel manager and chief engineer to have the power plant equipped with graphic recording instruments, the intelligent use of which will help reduce waste and loss.

Thus the power plant instrument board gives a very interesting guide and clue as to the overall efficiency of the power plant.

Water Power Development in Japan

JAPAN is pushing work on hydroelectric development as the demand for power in the larger cities as well as the smaller villages is far in excess of the supply available, according to Stephen Q. Hayes, a special electrical engineer of the Westinghouse Electric & Manufacturing Co., who recently returned from a 6 mo. tour of Australia and Japan, where he made a special study of business conditions. Tokyo and Yokohama, near the eastern end of the main island, are supplied with power at 50 cycles from many hydroelectric plants and there is an electrified section of the railway between these two cities with multiple unit trains every 10 or 15 min.

Near the middle of the main island, about 350 mi. from Yokohama and Tokyo, are the large manufacturing cities of Kyoto, Asoka and Kobe. These are fed by numerous transmission systems operating at 60 cycles. Some of the most important hydroelectric generating stations are located about halfway between the two groups of cities and some interesting problems are envolved in making some of these stations suitable for feeding 50-cycle current to Tokyo and Yokohama and 60-cycle current to Kyoto, Osaka and Kobe.

As the demand for light and power in the large cities is so greatly in excess of the available supply, rates are high and the distributing companies have not encouraged the use of electric heating appliances and household utensils. When the contemplated extensions to the power companies' systems are completed in the next few years, there will probably be a wonderful market for electric cooking and heating appliances and labor-saving devices.

Correction Note

Our attention has been called to the transposition of cuts which appeared in connection with the article entitled "A New Type Underfeed Stoker" on pages 934 and 935 of the Sept. 15 issue. The cut appearing as Fig. 2 should have been used as Fig. 4, the calculated performance curves being those designated as temperature of gases leaving boiler, combined boiler and furnace efficiency, pounds of coal per hour, stoker windbox pressure and volume of air. The typical test performance is a single curve showing combined boiler and furnace efficiency plotted against the per cent of boiler rating.

The International Joint Commission on the St. Lawrence Canal Project has submitted a report including estimate of $252,728,200 as the cost of this project. The report was made after a survey of the navigation, improvements and power sites as proposed in the St. Lawrence-Atlantic deep water project by a corps of engineers appointed by the United States and Canada. The estimate contemplates completing of the project in 8 yr. if all work is started simultaneously and sufficient funds made available.

Water Softener for Raw-Water Ice Plants

CHEMICAL ANALYSIS OF WATER TREATMENT AND THE ACTION OF A CONTINUOUS FLOW WATER SOFTENER. BY M. N. McILVAINE

FORMERLY, artificial ice was made chiefly from distilled water. The practice of recent years, however, has shown that ice, commonly called "raw-water ice," may be made more economically from undistilled water and if proper precautions are taken to remove the objectionable solids from the water before freezing, a superior quality of ice is produced. Raw-water ice properly made does not have the unpleasant taste frequently found in the core of distilled water ice which is probably caused by organic matter.

If raw-water ice is frozen solid in a can without agitation, the dissolved solids and gases are frozen into the ice as fast as they are forced out of solution, which makes a white and unsalable ice. To produce a clear ice, it is necessary to agitate the water in the can during the freezing process. The agitation is usually obtained by delivering a small quantity of high pressure air into the bottom of the can and permitting it to bubble to the top.

By agitating the water while freezing, the solids and gases are washed from the surface of the ice as the latter freezes from without. Some of the solids are thrown out of solution and are held in suspension in the core water. If the water is high in solids held in suspension, it is impossible to prevent some of these solids from freezing into the ice, even with vigorous agitation, and the core water becomes so high in soluble solids as to lower appreciably the rate of freezing. This makes necessary pumping a large amount of core water; sometimes two or three core pumpings are required.

The pumping of the core is costly, not only on account of the labor consumed and water wasted, but as the refilling water is comparatively high in temperature it delays refrigeration. The rate of cooling this water is slow on account of the surrounding ice being a poor conductor of heat. The purpose of purifying the water for ice manufacture is to reduce this core pumping; sometimes it completely eliminates this pumping.

The solids or impurities in water for ice manufacture may generally be included in two classes, as follows:

Class I. This class comprises those solids most easily thrown out of solution by freezing and which are held in suspension in the core water such as calcium bicarbonate which is precipitated as the white monocarbonate, $CaCO_3$; magnesium bicarbonate, precipitated probably as a basic carbonate, having a white color, i. e., a combination of $MgCO_3$ and $Mg(OH)_2$; iron, precipitated as red iron hydrate or iron oxide; aluminum, which is thrown down as white aluminum hydrate or oxide; silica, which is precipitated as the white silicon dioxide, SiO_2 with some water of hydration; and organic matter, only, some of which is precipitated and which is likely to be dark in color.

While the calcium carbonate, basic magnesium carbonate, silica and aluminum hydrate are stated to have a white color, this applies only to their pure form. When precipitated while freezing they are probably mixed with organic matter, which gives them a brownish or dark appearance. This applies particularly to the silica. As iron is always precipitated as a red product it is altogether objectionable for raw-water ice manufacture, as only a small amount discolors the ice. If any of these substances are frozen into the ice they will be deposited as insoluble residue when the ice melts.

Class II comprises those substances which concentrate and remain in solution in the core water. They are calcium sulphate and magnesium sulphate which are quite soluble and are rarely precipitated at the concentrations and temperatures usually prevailing; sodium sulphate and sodium chloride which are very soluble; sodium bicarbonate which is also very soluble, and concentrates as the mono-carbonate, Na_2CO_3; carbon dioxide, some of which is held in solution, part evaporates and some may be combined with the ice; and organic matter whose properties cannot be easily defined, as they depend upon the particular substance present.

As the substances causing most harm for raw-water ice manufacturers are those in suspension in the core water, it is most imperative that the substances under class I be removed for satisfactory raw-water ice manufacture. The best way of removing this material is by means of a lime treatment followed by efficient sedimentation and sand filtration. Lime not only removes, to a satisfactory low degree, the calcium bicarbonate, magnesium bicarbonate, iron and aluminum, but also reduces the silica and volatile and organic matter of class I and removes the magnesium sulphate and carbon dioxide of class II.

To remove the calcium sulphate would necessitate supplementing the lime treatment with soda ash; but as the calcium sulphate is not generally objectionable, it is questionable whether it pays to supplement the lime treatment with soda ash, unless the water to be used for ice manufacture is also to be used for boiler feed. In the latter case, it is generally advisable to feed both lime and soda ash, so that the water may be purified for ice manufacture and boiler feed by the same process.

The sodium salts can not be removed by any chemical treatment, but as these concentrate in the core water they are not as objectionable as other impurities. If, however, present in large amounts, as much as 40 or as 50 grains per gallon or higher, the advantages of the raw-water ice process are questionable.

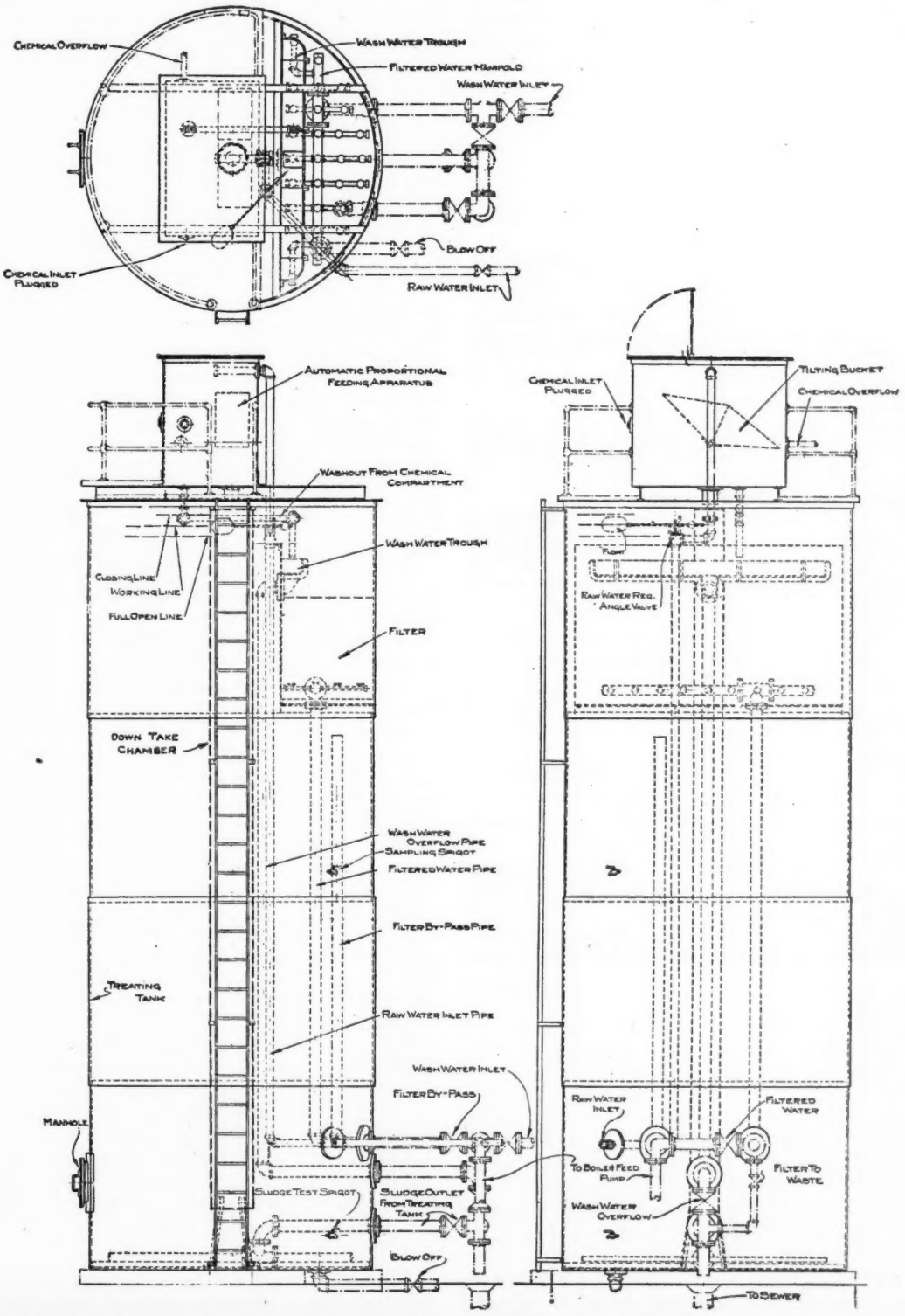
Raw-water ice plants generally require a softener of comparatively small capacity, often not over 1000 gal. per hr. A Cochrane 3200-gal. per hr. cold process water softener which has been installed to treat water having the analysis given in the first column of the accompanying table gives a water the analysis of which after treatment is given in the second column.

A softener for ice plant service should automatically proportion the chemical reagents according to the rate at which the water is withdrawn. As milk of lime is in all respects more convenient and desirable than a saturator the softener should also provide continuous and rigorous agitation in the chemical tank, preferably without requiring outside power.

A weighing chemical proportioner is used in the Cochrane cold process softener, shown herewith. . The

raw water enters the proportioner through a regulating valve controlled by a float in the sedimentation chamber and is discharged through a narrow orifice into a tilting bucket located in one of the two compartments of the chemical feed chamber. The bucket is divided by a middle partition into two wedge-shaped halves and is supported upon trunnions at the common apex of the two wedges.

The water flows into one side of the bucket until the center of gravity of the whole, including the water, shifts over to the other side of the axis, upon which the bucket quickly tilts over, emptying the side which has



COCHRANE COLD PROCESS WATER SOFTENER WITH WEIGHING CHEMICAL PROPORTIONER AND INTERNAL FILTER

just been filled and bringing its other side into the receiving position. The bucket thus acts as a water meter.

The chemical feed chamber contains a second compartment, in which is a cross arm carrying two small dippers, one at either end. The chemical solution is charged into the compartment containing the cross arm, and at each oscillation a small quantity is lifted up by one of the dippers into the compartment containing the water bucket, where the chemical mingles with the raw water. The treated water then flows into a downtake chamber extending from the top to near the bottom of the sedimentation tank.

Attached to the cross arm is a paddle by means of which the chemical solution is vigorously stirred at each oscillation. This paddle also serves to retard the motion of the tilting bucket and to prevent the latter from striking too forcibly against the buffer springs which limit its motion.

This type of chemical proportioner requires no outside power for operation and the feed of chemical is proportioned to the amount of raw water, regardless of the rate at which the water is withdrawn.

WATER ANALYSIS BEFORE AND AFTER TREATMENT

	GRAINS PER U.S. GALLON	
	RAW WATER	AFTER TREATMENT
Calcium carbonate	4.50	1.46
Calcium sulphate	9.05	....
Magnesium carbonate	4.25	1.87
Silica	.76	.18
Sodium carbonate	....	2.80
Sodium Sulphate	.29	8.98
Sodium chloride	.29	.29
Volatile and organic	4.44	2.74
Total solids by evaporation	23.60	18.40
Free carbon dioxide	.64	

The total encrusting solids, including silica, are reduced from 18.56 gr. per gal. to 3.61 gr.

In order to utilize the screening action which the coarse precipitates exert in collecting together and removing from the water the finer precipitated particles, the upflow design of sedimentation tank is used, the water being introduced at the bottom and withdrawn from the top of the tank. The precipitated solids are removed from the bottom of the sedimentation tank through a manifold with numerous distributed orifices. The area of the manifold pipe is larger than the aggregate area of the sludge orifices, insuring rapid and vigorous flow through the latter.

The filter compartment is built into the upper part of the sedimentation chamber, the softened water entering the top of the filtering compartment by overflowing the partition which separates it from the sedimentation space. The filter is easily accessible from the top and is large enough for a man to enter for shoveling out the filtered material. Inside of the filter, below the top of the partition just mentioned is a wash water trough connecting with a pipe leading to waste which receives the overflow when washing the sand and gravel filter.

The strainer valves are of a self-cleaning type, having a removable head or disc which rests upon projections on the stationary part of the valve, leaving small openings or ports around the edge. In backwashing, the water is admitted through the strainers in a reverse direction and lifts the discs or heads, increasing the openings or ports to double the normal size, with the result that any particles of sand or other substance which may have lodged in the ports during the filtering operation are released and carried out by the wash water.

A pipe ending just beneath the filter serves as a bypass for drawing water directly from the treating tank when the filter is for any reason out of service. This pipe is protected from sediment falling from above and at the same time its opening is far enough above the bottom of the sedimentation chamber to insure that it will receive reasonably well-settled water. As it is possible to draw all water in the treating tank from the working level down to the opening of this pipe, a good portion of the capacity of the treating tank is available for storage purposes.

Oil

By Chas. F. Knapp

THERE'S a little thing we fellows sometimes neglect to do; which, in truth is some important, for sometimes we're made to rue! It's in the way of lubrication; if we properly used our oil,—'twould save a great deal of expense, and, no doubt, a lot of toil. How many bearings have burned out, from the lack of lubrication; how many brasses might be saved,—with oil and some attention? Who hasn't heard the grinding valves, or the squeaky, laboring piston, and found the symptoms of it all; insufficient lubrication? We all try to economize; but the true road of economy lies not in a quart of oil,—with dry, worn out machinery! Better use the quart of oil, whenever, wherever needed; a drop in time, sometimes saves nine,—a good rule, too, if heeded!

THE FIRST approval of an industrial gas mask for use in ammonia fumes has been issued by the United States Bureau of Mines for the Burrell ammonia mask which successfully passed the exhaustive series of tests given by the bureau's chemists.

The approval issued to cover this mask states that the mask is approved for safety, practicability and efficiency in concentrations of ammonia in air not exceeding 3 per cent for short periods of time, as 10 min., or for periods of 20 to 30 min. in air not exceeding 2 per cent ammonia, and for proportionately longer periods of time in lower concentrations.

The Burrell ammonia mask consists of an Akron type, Tissot face piece that allows breathing through the nose, fitted with a special ammonia canister containing copper sulphate pumice stone mixture devised by G. St. J. Perrott, Max Yablick and A. C. Fieldner for the Ordnance Department of the United States Army. It has been found to give protection in any percentage of ammonia gas which the wearer of a mask can stand without unbearable skin irritation.

The canisters submitted protected successfully against 3 per cent of ammonia at a breathing rate of 64 liters per minute for a period of 5 min. This represents the maximum concentration that anyone is likely to enter, as it has a very strong action on the skin. In a concentration of 2 per cent ammonia and a breathing rate of 32 liters per minute, corresponding to active work, 6 canisters gave a service period of 30 to 41 min. The requirement for approval is 20 min.

THE SHALLS and shall nots of desire, prejudice and expediency are so numerous as to lose the untrained man in a wilderness of doubt.

Hunting Trouble---V

How Considerable Savings Were Effected by Changing Method of Elevator Operation, and How the Ore "Charge Tank" Capacity Was Increased. By John Pierce

GOING to work a few mornings after I had settled down and got into the harness, I felt that I'd like to see if I could make some sort of showing, as I could see numerous places that looked to me to be very inefficient, and which fairly cried aloud to be fixed. So I got out my trusty pencil and my old Ingersoll and went to taking count of what I could see. I decided to begin on the elevators, and I found that a certain number of "charge" cars had to be elevated in a certain length of time in order to keep the furnaces supplied with coke, iron, lime, and ore.

After timing the double electrics for about 2 hr., I found that they alone, without the aid of the hydraulics, had nearly double the capacity that was required, though they did not go either up or down with the speed of the water driven platforms. I also found, on referring to the reports for months, and years, back, that these electrics were kept running continuously even though the hydraulics were in use; that is, the belts, wheels, shafting and motors were kept going. It developed that they used only a small additional horsepower more when pulling their load of two charge cars each than when the motors were idling, owing partly to the fact that they were balanced and the one going down helped the one going up.

I then took tabs on the hydraulics. I found that these were driven by a large direct-current motor, and this in turn was driving a belted—short belt at that and therefore extremely tight—triplex pump. This pump put its water into three large accumulators which held the hydraulics steady and did away with the jar caused by the pulsation of the pump. This motor load showed, by actual tests with the instruments, that it was consuming 60 hp. in order to perform its work—while the combined horsepower consumed by the electrics while doing all the work of elevating was only 25, and a trifle over 15 hp. when idling; therefore I discovered that by increasing my load on the electrics' motors about 10 hp. I could save the 60 hp. consumed by the hydraulics, or a saving over all of 50 hp.

Now, when you are away off in the jungles of Mexico, where fuel as well as every other commodity is hard to get, the saving of 50 hp. is some little item, believe me. It was very amusing though, at first. The peons who did the elevating of the charges were accustomed, for many years, to turn their cars up and over the scales, allowing them to pile up at the foot of the elevator, and then when the time came for a new charge, would shoot them up quickly on the hydraulics and directly to the furnaces. Using the electrics only, they being so very much slower, they were obliged to elevate their cars as fast as they were loaded, piling them up on the upper, or "charge" floor, so as to be ready when the time for "charging" came. This interfered with their rest only in that it required them to rest where the gas from the furnace was much stronger, and therefore they did not like it. The walls, or shaft, of the elevators were lined with sheathing, and it was amusing to watch them try to arrange their cars so that they would tend to hook in under this sheathing and pull it loose, thereby forcing that elevator to shut down and throwing the nearest hydraulic into service again. In fact, they got so bad that they deliberately would pry the sheathing loose with bars and do many other things in order to knock them out, until finally we had to threaten to fire the whole bunch if it happened any more. It did not happen again, and eventually they were apparently better pleased with this arrangement than with the old.

In addition to the saving made in power, I want to say that the rods of the hydraulic elevators were so scored by long and constant use that they would not

FIG. 1. THEY WOULD DELIBERATELY PRY THE SHEATHING LOOSE WITH BARS

hold packing at all—and the accumulators were in the same condition. It required the services of one first-class man to whom I paid nine pesos daily, or $4.50 U. S. gold, and two helpers at four pesos each, or $2 U. S. gold, a day. The cost price of the rawhide packing figured $27 a day, U. S. currency. Therefore with these elevators down you can easily figure that it meant a daily saving of considerable magnitude. Of course, I kept them packed and in shape to go on a moment's notice, so that there would be absolutely no delay once they were needed.

Another way in which a further saving was established was as follows: The engine driving the generator

—in fact, the generator itself—was loaded to capacity, and could handle no more. In the main pump house there were several direct-connected motor-driven centrifugal pumps, in addition to the steam pumps. We had enough current, while the hydraulics were operating, to handle two of these motor-driven units, which were both large capacity pumps, but did not have enough current to run the third one. Therefore two large duplex steam pumps were used to help handle the furnace jacket water, and they were driven at a good snappy speed, while ofttimes the third one was cut in. These were the old wasteful simple expansion animals, and, like all other steam pumps, were exceedingly wasteful of steam. By my discontinuing the use of the hydraulic elevators, I gained enough current so that I could cut in this third motor-driven centrifugal and "lay off" the steam pumps. It is readily seen, therefore, that, everything considered, the saving effected was considerable.

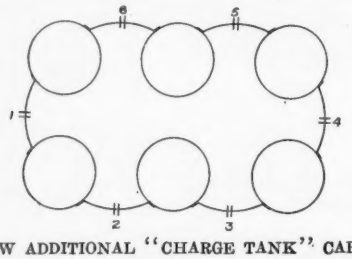


FIG. 2. HOW ADDITIONAL "CHARGE TANK" CAPACITY WAS OBTAINED

As I said in my first article, however, the old master did not claim to know a thing about electrical work nor the methods whereby he could calculate the horsepower used, or even made. To him a machine was working right if it was not heating or sparking, and was not working right if it did either of those things. To him a "watt" or an "ampere" or a "volt" was a watt, ampere or volt, nothing else, holding any significance whatever. He did object some, however, on having the change, as I have described it, put into effect, saying that it was a good thing—"in fact, a damn good thing, but what the hell will the head guys say when they find it out, and what will *I* say when they ask why I didn't do this years ago?" But, being a broadminded man, he finally said to go ahead and "stick her in." So we put it to going, and the results were wonderful.

Increasing the Capacity of the "Charge Tanks"

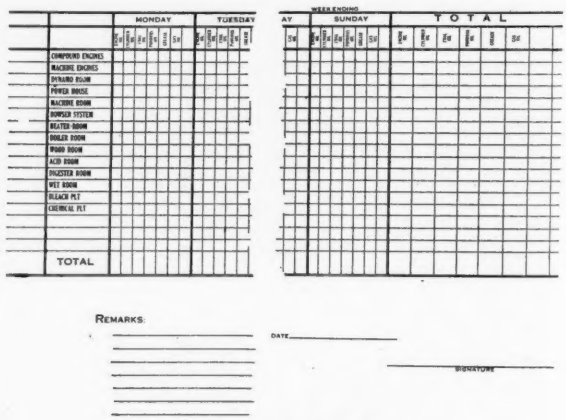
Soon after this, the company decided to build a few more tanks for containing ore, called "charge tanks." They had six tanks 50 ft. high, and 20 ft. in diameter arranged in two rows of three each, and from center to center of each tank to its neighbor was 30 ft., with nearly 5 ft. of space between each two tanks. On the bottom at the outside of each tank was a chute and gate. The "charge cars" were run under these chutes, the gate raised and the ore would run from the tanks to the cars. The ore originally was dumped from railroad dump cars into a hopper, then elevated to the top of the tanks. Sheet steel for tanks was hard to get, the railroads then, as now, being in very incompetent hands; no freight was moving and the outlook for building new tanks was not very bright. Yet the superintendent felt that a great labor saving and also a financial saving could be effected by the installation of new tanks. He knew that we had some steel on hand, but did not have enough to build another half dozen containers, and began to feel somewhat discouraged. One day he was talking to me and I remarked that I believed I could solve the question for him, not getting as much tankage, perhaps, as he might want, but considerably more room than what we had, as well as avoid the expense of putting up a new elevator and motor to drive it.

I expected him to ask the usual routine of questions about how I'd do it, and a lot of other foolish things, as well as to find fault in a dozen different ways with my project. For a wonder, he did nothing of the kind but told me at once that though wages were set in the New York office for all the craftsmen employed, he would take it on himself to increase my wages $25 a month. So I got busy. In the end, I had my six tanks, as shown in Fig. 2, with a discharging spout at 1, 2, 3, 4, 5 and 6. At the top of the tank—the discharge to the elevator coming into the center of the original six tanks and distributed by swinging spouts—I had only to swing the spout into the space between the tanks in order to fill the new space. It is needless to say the superintendent was well pleased and that he kept his word to me and raised my pay 25 bones more per month. It is true I had to use some old steel that I secured by tearing up some old furnace jackets, yet it could have been used to no better purpose. In my next article I shall tell you how I raised the evaporation rate of the boilers.

Sample Oil Report

By John A. Kagerhuber

IN ORDER to keep track of the quantity of various kinds of oil used in a plant and to show where such oil is being used, it is desirable to have some sort of form on which the various items in regard to oil consumption may be easily recorded. In this connection



WEEKLY OIL REPORT

the accompanying sample oil report which was prepared by the author for use in a pulp and paper mill in Pennsylvania may be of interest to some of the readers.

This, as will be seen, is a weekly report, giving the engineer in charge a complete record of every bit of oil used.

Troubles with Pump Valves

Various Causes of Wear of Pump Valves and Methods of Remedying. By R. A. Cultra

TROUBLES experienced recently with a new vacuum pump and the valves of the water end and others of the past lead me to believe that my experience may interest readers.

In Fig. 1 is the composition hard rubber valve disc which was taken from the vacuum pump mentioned. A is the top side view of the disc which was worn out at d and c as the shaded portion shows to a depth of ⅜ in. The original thickness was ⅝ in. This is better seen by the dotted line at e in part B. The pump failed to work and when opened up two of the discharge valves were missing; no trace could be found of them.

Two new valves were put on, then it was decided best to renew the full set, which showed the center portion worn as above stated on the others; but the cause of the wear was a mystery for a time. The quality of the valves was not of the best, and there were no plates on the top side to prevent the springs from wearing into the top side of the discs; but as many pumps use composition hard rubber valves with the springs bearing on the discs without a metal plate between them, little was thought of the real cause for some time until it was discovered by accident that the old spring was being compressed on one of the valve bolts with valve disc in place.

It was seen that the valve was worn out by coming in contact with the rounded shoulder under the head of the bolt as seen at Z, in Fig. 3, which shows the valve V in the open position. This shoulder is also shown at S in Fig. 2. Its purpose is to hold the top of the valve spring S in position. The spring fits snugly over this shoulder and when the valve is opened the spring is compressed as shown at S in Fig. 3. This allowed the valve to strike and wear away; but why should it strike with force when it had the tension of the spring to resist?

This brought to mind a previous incident where I found the heads gone off two valve bolts of the type shown at b in Fig. 4, in a pump which was used in the same kind of service. The case of Fig. 4, however, was due to slamming of the valves on account of excessive air leakage into the piping system. The vacuum pump using valves shown in Figs. 1 and 3 was new, as was also the system on which it was used; furthermore, it was tight and free from air leaks. It was thus apparent that the wear was due in part to lack of metal plates above the valve as shown at M in Fig. 2, which were later put on.

While waiting for the plates to be made I noticed one morning that the pump had much rebound at each end of the piston stroke. This seemed to mean that the stroke of the pump was too short for the amount of vacuum carried; in other words, it did not come to a gentle stop at each end, but jumped back an inch or two. The tappets, T, T, on the valve stem, Fig. 7, were set in as close to the sleeve, n, as the thread on the stem would allow. This put the tappets in the position of the arrows, e′, e′, causing the pump to run faster when the vacuum was lost without the piston striking the cylinder heads. In Fig. 7, part A, J, J, of the rocker arms is omitted at d,d, to show the sleeve on valve stem.

I learned that the night men had been changing the tappets, T, T, to this position from that which the pump had been set at e, e, because the pump hung up and stopped on starting in the morning and when it was finally gotten under way it would strike the heads. This was due to lack of time to warm up the steam cylinder and pump out the heating system before the steam was turned onto the heating system. They turned the steam on to the heating system first, then tried to start the pump. The pump did not start because the condensate in the auxiliary steam chest choked the auxiliary steam piston and prevented it from moving the main steam valve. When the pump finally got to going the return pipe was full of condensate and the pockets of the system full of air and the water and air would come back to the pump in alternating slugs of air and water. This discharge from the water cylinders of air

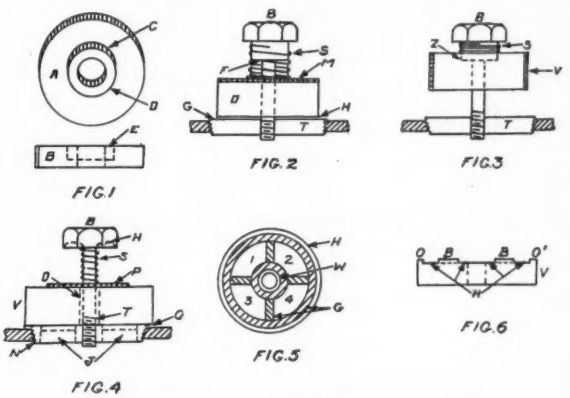


FIG. 1. PUMP VALVE DAMAGED IN SERVICE
FIG. 2. VALVE, BOLT AND SPRING IN POSITION
FIG. 3. PUMP VALVE IN OPEN POSITION
FIG. 4. STRAIGHT TYPE OF VALVE BOLT WITH OPEN THREAD
FIG. 5. HOW VALVE DISC WEARS ON FACE
FIG. 6. BEARING SURFACE OF THE VALVE FACE

and water combined came against the discharge valve with terrific force in order to open it and when the valve had risen a trifle off its grid seat, T, in Fig. 3, there was a larger area of the valve disc, V, exposed to the pressure of discharge through the grid seat. This extra area exposed to the pressure sent the disc up with great velocity hard against the shoulder and head of the valve bolt until the disc was worn away, as its fiber was soft enough partially to absorb the shock and thus saved the bolt from breaking. Had a metal plate been used on the valve, the bolt would have broken off either where it was screwed into the grid seat or under the head or shoulder wherever the weakest point was.

After this was discovered, metal plates were used on top of the valve to prevent the valves from wearing away as shown in Fig. 1, and the tappets were set at e, e. By starting the steam on the pump in time to

warm it up and pump out the heating system before the steam was turned on to heat the buildings and by allowing the pump to run under the control of the vacuum regulator instead of the bypass throttle, the pump maintained a more even speed. Air escaped through the valves without slamming against the shoulders and heads of the valve bolts, since the piston was brought to an easy, gentle stop at each end, which gave the valves time to rise easily against the tension of the spring until it was up against the shoulder or head of the bolts. In this case, the valves had broken in several pieces which became wedged in various stop valves along the supply line to the feed pumps.

Small Cylinder Clearance Causes Wear of Valves

I HAVE NOTICED with vacuum pumps that the length of the water cylinder is much nearer the length of the steam cylinder. In Fig. 7 the steam cylinder is 10 in.

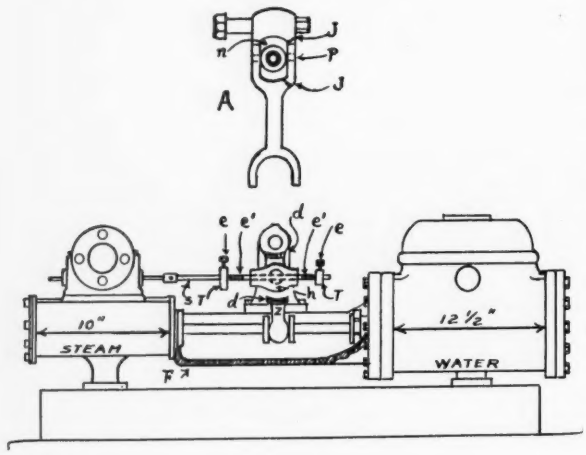


FIG. 7

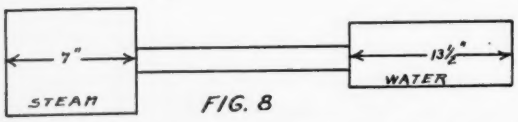


FIG. 8

FIG. 7. SKETCH SHOWING TAPPET ADJUSTMENTS ON VALVE STEM OF VACUUM PUMP

FIG. 8. LENGTH OF STEAM AND WATER CYLINDERS OF ODD SIZE WATER FEED PUMP

between flanges and the water cylinder 12½ in. This is partially taken up by the difference in the thickness of the pistons of the steam and water cylinders, as the piston in the water end is generally thicker than the piston in the steam end. Thus the clearance between the piston and cylinder head in the water end is much smaller in a vacuum pump than it is in many boiler feed pumps, especially a duplex type of feed pump, a diagram of which is shown in Fig. 8.

The steam cylinder is 7 in. and the water cylinder 13½ in. between flanges. Though this size feed pump is an odd one not generally desired for boiler feeding, there are many in use. The smaller amount of clearance in the vacuum pump, together with the amount of air which a vacuum pump has to handle, mingled with more or less water, and having the tappets set close together as shown at e′, e′, giving much rebound to the piston at each end of the stroke, makes the wear and tear of the valves and springs of a vacuum pump more severe than on almost any other type of pump. A vacuum pump may get a full cylinder volume of water on one stroke, and almost a full cylinder volume of air on the next stroke; this causes slamming of the valves which in turn causes the valve springs and bolts to break as well as excessive wear on the valves and seats.

Figure 2 illustrates a common form of valve construction for boiler feed and other moderate pressure pumps; but one special point of interest is at G and H. It will be seen that the valve disc, D, does not extend over the full outside area of the grid seat, T.

I was told on taking charge of one plant that the pump was in good condition, as new valves and springs had been put in two weeks previously; but about 10 days later the pump refused to keep up the water in the boilers. On taking out the valves I found the water had been surging back and forth through the grid seat, T, at the points g and h, until the edge of the valve was worn away by the friction of the water. There was not enough bearing surface on the edge of the valve to hold the pressure on the disc, and it was soon cut away. The discs should be the same diameter as the grid seats to insure this surface or the water will leak back under the edge of the valve and soon wear the edge off.

In Fig. 4, N shows the thickness of the outside rim of the grid seat, the top side being wider to make a good tight joint with sufficient area for the disc V to rest on without unnecessary wear on the disc or seat. Figure 4 shows that the valve, V, is larger in diameter than the grid seat, allowing the edge of the valve, V, to lap over the seat as shown at O. There was a small recess on the under side of the head of the bolt indicated by the dotted line, h, which seemed to cause the spring to spread at the top when compressed, and which probably caused the wear of the spring. The extra area of the valve, exposed to the pressure after it had opened enough to let water through, caused it to rise with greater velocity, strike the heads of the bolts hard and jam the springs. Then this extra area with the pressure on the back of it caused the valve to pound when closing, which wore recesses in the under side of the valve where it rested on the bars of the grid seat G, Fig. 5. As the valve did not rotate but closed in the same position, the wear continued until the rim of the grid seat had worn a perfect annular recess in the valve and the overhanging lip, H, and the parts 1-2-3-4, pressing farther down between the bars of the grid seats, while the hole in the center was also worn out by constant rubbing against the thread, T, which remained above the valve seat and "filed" off the inside of the hole, until it was large enough to allow water to leak through, if it shifted to one side more than the other.

In most pumps the valve bolts are made with the thread cut up to a shoulder, so when the bolt is screwed into the seat no thread is exposed to wear out the inside of the hole through the valve. In Fig. 6, V is an edge view of the hard rubber valve and H shows the amount of wear. O and O′ show the lip edge which extended over the edge of the grid seat, and B the bumps indi-

cated at 1-2-3-4 in Fig. 5. If this valve should turn around enough in closing to bring these bumps over the bars in the seat, the pump would lose the water, as it would flow through the worn recesses.

In Fig. 4 the metal plate, P, on top of the valve was much smaller than the valve and though it prevented the spring, S, from wearing into the valve, it did not prevent the top uncovered edge of the valve from turning up 1/32 in., and this dished condition prevented the valve from being turned over and used for an equal length of time, other side up, which would have saved half the expense of renewing the valves. In this case the pump always had a heavy chug or thud sound at each end of the stroke. New valves and plates the exact size of the grid seats and bolts with thread turned up to a shoulder were put in. The springs used were stiff enough to prevent the valve from striking against the heads of the bolts and jamming the spring, though cutting the valve down to the same diameter of the grid seat had much to do in lessening the force of striking against the head of the bolt. If the springs are too stiff they will increase the resistance of the discharge of water through the valve and require more steam pressure for the same amount pumped.

In some fire pumps where the valves were intended for use with cold water and the pump stands idle for periods of a week or more in a very warm room, the water in the pump will become warm enough to cause ordinary cold water valves to expand and become so soft that they will be pressed down into the grid seats. They will then fail to hold the pressure if they turn around before closing. A cold water valve is usually made of softer material than that used for hot water and for temperatures of 100 to 125 deg. a semi-hard rubber valve will give the best service, while for temperatures of 212 deg. or more, hard composition rubber or metal valves should be used.

Figure 9 illustrates a metal valve which gave good service for some time until it met with trouble caused by a piece of packing lodging under one edge, which caused it to become bent up at D. The pump took the water from an open heater most of the time. The valves had been machined before the packing caught beneath it, which made it quite thin, and though it was bent, it managed to hold the pressure sufficiently to keep water in the boiler. One day, however, the plant was closed down and water had to be pumped from the well. The pump failed to get the water.

When opened up, the bent valve was quickly noticed. Depressions had been cast on the back as shown at a and b. Figure 10, A, shows an edge view with this depression on the back at d,d, and recesses a, a, on the face side. The depressions d, d, were worn deeper by the valve springs, which were too large. This left the metal very thin and in machining the mechanic cut off more at h than he did at e and e', which left no support for the center portion of the new thin valve. The pressure forced it down onto the center of the grid seat, causing the outer edge to spread and distort until the face assumed the angle e-e', with the result that there was so much slippage of the pump from leakage that the pistons could not discharge the air from the suction pipe when pumping from the well.

Some of the valves had been so worn around the bolts that the valve could slip sidewise enough to overlap the edge of the seat, which had been machined down until it was below the surface of the valve deck, and when the valve slipped sidewise the edge was also held up by the surface of the valve deck beneath it. New valves, bolts and springs were put in. Metal valves must not be worn down too thin. It is good policy, when ordering new hard rubber composition valves, to get them from 1/32 to 1/16 in. thicker than is actually needed to hold the pressure. This extra thickness will permit the valves to be faced up on the lathe or with a file when they become worn about 1/32 in. on each side and they can be used much longer until the hole in the center becomes so worn as to allow leakage. This will reduce the expense for valves about 65 per cent, which in large pumps with 96 or more valves is quite an item. With metal valves, about 1/32 in. extra thickness when new is about all that can be added, as the valve is heavy and more apt to stick on, and wear out the valve bolts.

Soft Rubber Valves

In many jet condensers the valves are made of semi-soft rubber and large diameters. The valves being

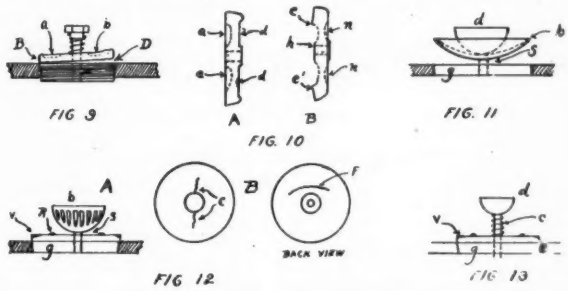


FIG. 9. METAL DISC DISTORTED
FIG. 10. METAL DISCS, EDGE VIEW
FIG. 11. JET CONDENSER VALVE, BUCKET PUMP IN OPEN POSITION
FIG. 12. PERFORATED TOP TO VALVE BOLT IN BUCKET PUMP JET CONDENSER
FIG. 13. SAME AS FIG. 12 EXCEPT WITH LONG BOLT AND CONE SPRING

soft, insure perfect fit to the grid seat, which not only prevents leakage back through the seat but the soft rubber valves do not wear off the face of the seats as hard composition rubber valves would. On condensers only discharging against atmospheric pressure, hard valves are not needed to withstand pressure, and heat is only moderate. Larger valves can be used, which allows for larger valve area of opening and less resistance for discharge.

In Fig. 11 is a type of valve and bolt used on a new vertical jet condenser of the twin type, installed in the same city where it was made. The designer sought to try out this type of valve, 8 in. in diameter semi-soft rubber, shown at b in an open position; g is the grid valve seat, d is the top visible part of the 5-in. perforated cup-shaped head of the valve bolt, around which the valve doubles up in the shape of a wash basin when it opens. The object of this design was to dispense with the springs as far as possible, making the flexibility of the soft rubber valve serve as the spring

to insure proper closing when the bucket started to rise. The condenser was guaranteed to maintain 26 in. of vacuum at full load, but could not get over 25 at any time and carried 23 in. On full load it dropped back to 21 in. unless another condenser was put on as a helper.

After much study of conditions a set of valves were put on with a reinforcement ring on the back as shown at R in Fig. 12, which also shows the perforated cup-shaped bolt head, b. But while these valves lasted somewhat longer, there was little difference in operation; they broke just the same, or cracked as shown at c in Figs. 12 and 13. At last the designers concluded that the cause was the short lift of the valve on the bolt, as the buckets were slow in descending in spite of all operation of the steam valve to aid it. When the steam valve was adjusted for this purpose, the rebound was great and also the destruction of the valves in the bucket. It will be seen in Fig. 11, at S, that the valve does not rise off the seat surrounding the bolt enough (only ½ in.) to allow of free discharge of the water through the seat. The space S in Fig. 12 is also ½ in. between the cup-shaped head and the valve and this constant bending of the valve over this cup head was the cause of the cracking and breaking.

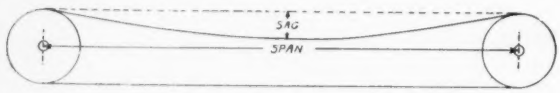


FIG. 1. DIAGRAM SHOWING WHERE SAG SHOULD BE MEASURED

In Fig. 13 is shown the design of the valve bolt, being made much longer with the same cup-shaped head, d, which, however, was less than half the size of the heads in Figs. 11 and 12. Beneath this bolt head pressing against the valve was a cone-shaped valve spring, e, which compressed, when the valve opened, clear up to and surrounding the bolt head and returned to place as the valve seated. This allowed the valve to remain in a flat position until it was open full area and then instead of being distorted over the bottom of the cup-shaped head, it was warped over the large bottom coil of the cone-shaped spring which took the pulling stress away from the rubber surrounding the bolt and thus prevented the valves from cracking. This change allowed the buckets to descend much more easily and quickly and still the valve closed quickly with the reverse of the piston stroke and the rebound was corrected by moving the tappets on the valve steam as mentioned in Fig. 7. This change in the valve bolts allowing the valve a greater lift caused the condenser to work so much better that 25 in. of vacuum could be carried with full load, although guarantee of 26 in. was never reached.

ARTHUR J. HOSKINS, prominent mining engineer, is leaving Denver to take up the duties of assistant research professor at the University of Illinois, Urbana, Ill. Mr. Hoskins for the past eight years has been a consulting engineer in Denver and previous to that was professor of mining at the Colorado School of Mines.

Belt Tension Chart

BY W. F. SCHAPHORST*

THE QUESTION is often asked, "How can we measure the tension in belts while they are on the pulleys?" Here is a chart that the reader will find of much assistance for determining the tension in horizontal or nearly horizontal belts. No tension indicating instruments are needed. It is simply necessary to know the span of the belt or the distance between shaft centers, in feet, and the sag of the belt at the center as indicated in Fig. 1.

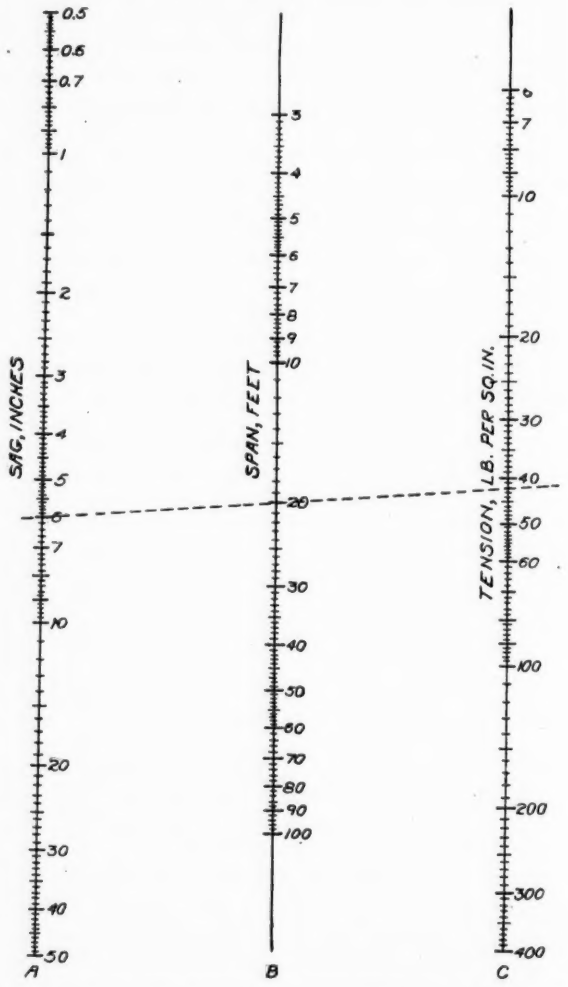


FIG. 2. CHART FOR MEASURING THE TENSION IN LEATHER BELTS

It is a simple matter to measure the span, of course, and the sag can likewise be measured with great accuracy by simply sighting across from pulley edge to pulley edge and measuring the distance from the straight line connecting the two pulley edges to the point of maximum sag in the belt.

Figure 1 shows a belt that is pulling a load. That is, the lower half of the belt is tight. Of course, no horizontal belt is ever perfectly straight even on the tight side, as drawn in the sketch. There will always

* All rights reserved by the author.

be a sag no matter how great the tension. This sag can sometimes be measured even while the belt is running with sufficient accuracy to determine closely the tension in the tight side of the belt.

The tension in the slack is of course easier to determine while running because it invariably has much more sag.

When the belt is not running at all, and when it is not pulling any load, the sag in the upper and lower half of the belt is usually the same, at which time the so-called "initial tension" is easily measured in this manner.

After knowing the sag and span, all that one has to do is to run a straight line through the corresponding figures in the chart, Fig. 2, and the tension in the belt in pounds per square inches is quickly determined in column C.

For example: What is the tension in a leather belt having a span of 20 ft. and a sag of 6 in.?

Run a straight line through the 6, column A, of the chart and through the 20, column B, and the intersection with column C gives the answer as 42 lb. per sq. in.

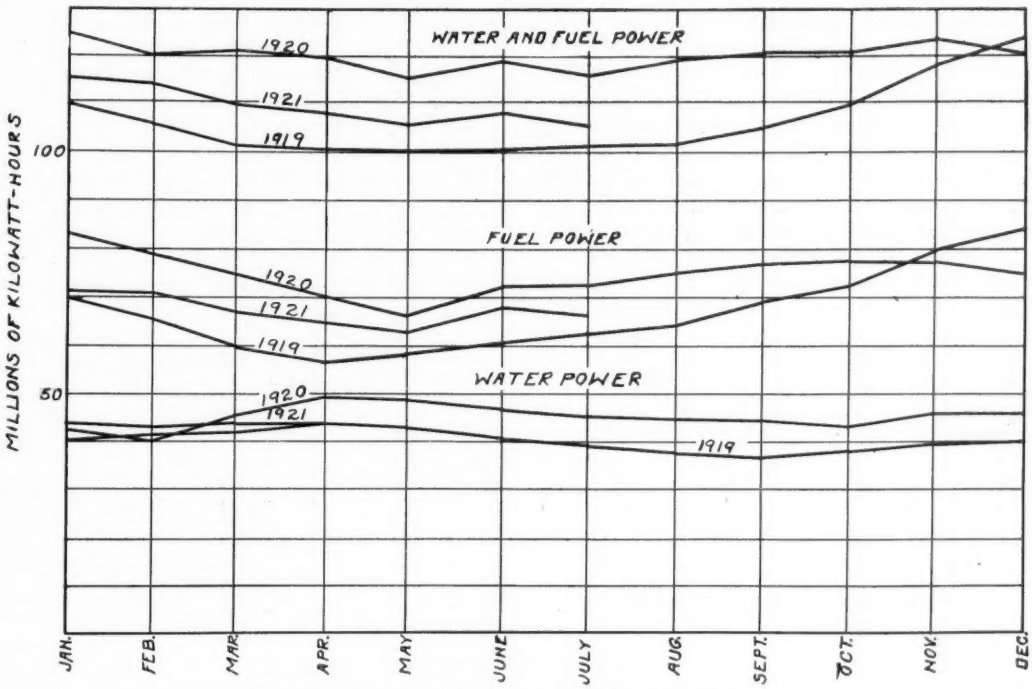
The range of the chart, as will be noted, is great enough to cover all ordinary cases.

According to the United States Bureau of Standards, single leather belting should have a strength of 4000 lb. per sq. in., and double leather belting a strength of 3600 lb. per sq. in. It is stated that the tensile strength of chrome leather varies from 8500 and 12,000 lb. per sq. in.

To increase the convenience of the chart, it might be well to point out that if the sag were 0.6 in. instead of 6 in. the same dotted line drawn across the chart would show the tension to be 420 lb. per sq. in. instead of 42 lb. per sq. in. In other words, by moving the decimal point one place to the left in column A you move the decimal point one place to the right in column C. By remembering this, it becomes an easy matter to determine tensions very accurately where the sag may be as little as 0.1.

Production of Electric Power by Public Utility Plants

REPORTS RECEIVED from the United States Geological Survey show that the average daily production of electric power by public utility plants for the months of March, April, May, June and July of this year, is about ten millions of kilowatt-hours less than it was for the corresponding months of 1920.



AVERAGE IS OBTAINED BY DIVIDING THE TOTAL FOR THE MONTH BY NUMBER OF DAYS IN THE MONTH.

AVERAGE DAILY PRODUCTION OF ELECTRICITY BY PUBLIC UTILITY PLANTS IN THE UNITED STATES

The quantities on which the accompanying chart is based, were compiled from returns received from about 3200 power plants of 100-kw. capacity, or more, engaged in public service, including central stations, electric railways, and certain other plants which contribute to the public supply.

The capacity of plants submitting reports of their operations is about 95 per cent of the capacity of all plants listed. The output of plants which do not report is estimated.

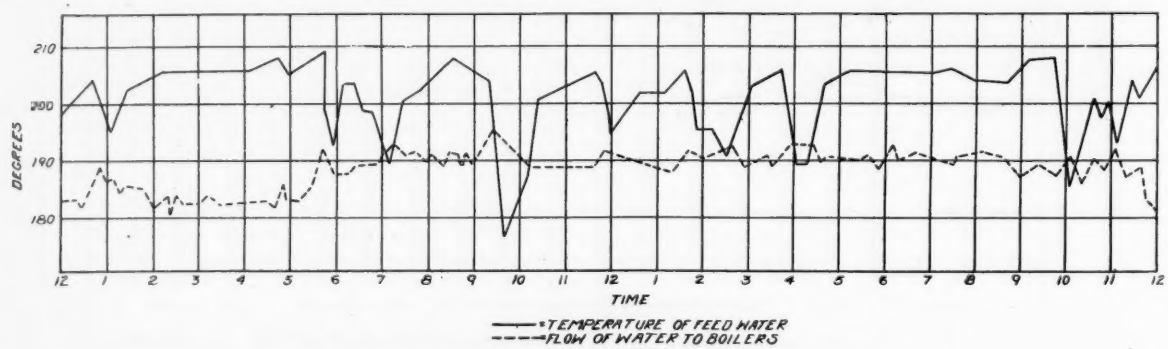
The mean daily output in kilowatt-hours for January, February, March, April, May, June and July was 114,200,000; 113,400,000; 109,600,000; 108,000,000; 105,300,000; 108,100,000 and 105,500,000, respectively. The proportion produced by water-power was as follows: 37.9, 37.7, 39.6, 40.4, 40.5, 37.2 and 37.5 per cent, respectively.

Feed Water Control

CHANGE of temperature and water flow, as shown on the accompanying sketch, illustrates the need of feed-water regulators. The solid line represents the feed-water temperature and the dotted line the feed-water flow. The diagram shows that every time there was a sudden heavy demand for water, the temperature dropped at once. A constant even feed would have prevented this.

As long as the demand for water is constant and there is ample steam for heating the water, there should not be violent changes in the temperature of the feed water. If the feed is regulated by hand, there will always be sudden changes in the amount of water needed, and these sudden changes will overload the feed-water heater, causing a loss in feed-water temperature and hence, a loss in fuel. Then if there be a minimum amount of water used, due to hand regulation, there will be a surplus of auxiliary steam with the consequence that there will be a waste of steam. It is impossible to get proper control of the feed by hand regulation, therefore we must resort to automatic regulation. Some of the advantages of perfect feed-water control are as follows: First, more uniform steam flow from boilers; second, constant level of water in boilers for given output; third, more uniform superheat temperature and a higher superheat; fourth, higher feed-water temperature; fifth, less tendency to prime.

FREDERICK L. RAY.



GRAPHIC RECORD OF FEED WATER TEMPERATURE AND FLOW

Cinder Trouble Eliminated

ANNOYANCE is often encountered around power plants operating at high draft intensities in the furnace on account of soot particles and cinders being blown up the stack, to fall in proximity to the plant. The objections to this become greater where the surrounding territory is well populated, and the neighborhood is residential as contrasted with a manufacturing locality.

The capacity of a smokestack is dependent upon its height and its diameter. The height determines what "draft" the stack can exert for a given temperature difference and atmospheric condition while the diameter or area determines the quantity of gas that can pass up the stack in a definite time. For a given draft, the velocity of the gases passing up the chimney will vary with the area of the stack, velocity decreasing as the diameter of the stack increases. This fact can be utilized in reducing the amount of cinder and soot particles scattered about a neighborhood.

When high draft intensities came into vogue, as with forced and induced draft, various methods of reducing the effluence from the stacks were adopted. Screens were tried in the second or third passes of the boiler, but these clogged up, choked the gas passages and obstructed the draft, so cutting down boiler capacity. Dust or cinder catchers were then used, and while these are still in use, possibly, in one or two large plants around New York City, they have never found wide usage because they cut down the draft, occupy considerable space, are somewhat expensive and have relatively short life because of corrosion. Moreover, they are only partially successful in stopping solids.

The writer recently visited a plant where the problem of soot particles had been overcome in an interesting manner. In making extensions to the plant, it was decided to use a concrete instead of a steel stack, as was formerly employed. This concrete stack, like all concrete and brick stacks, had a much larger base than steel stacks ordinarily have. The breeching entered the stack about 45 ft. from the ground and the base of the stack had an internal diameter of approximately 17 ft.

In other words, the concrete stack had a huge settling chamber at its base, measuring about 35 ft. high and 17 ft. in diameter. The height was, moreover, some-

what greater than the older steel stacks. This settling chamber solved the nuisance due to the soot particles and small cinders.

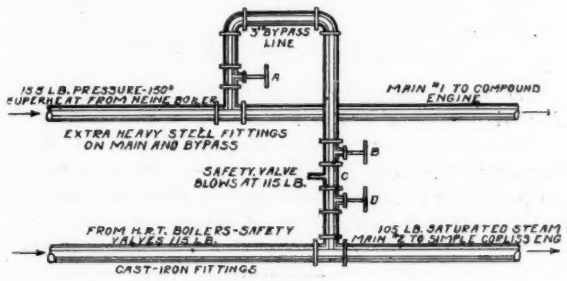
The velocity of the gases was lower than in the steel stacks because of the larger cross-sectional area. Before the solids in the flue gases emerged from the stack, they were overcome by gravity and fell into the settling chamber at the base of the stack. It was found that this chamber, 17 ft. in diameter and over 35 ft. in height, would be filled to a height of 30 ft. in a month during the winter.

It is generally cheaper to increase the height than to increase the diameter of a stack. The influence of stack area upon capacity as well as solids discharged to the atmosphere is deserving of consideration where plants are in locations where flue-gas dust can do damage.

R. K. Long.

Bleeding Into Low Pressure System

I have followed with considerable interest the comments on Mr. Wakeman's article in regard to cutting in boilers having a difference in pressure of as much as 50 lb., and should like to describe an installation which was designed by the chief mechanical engineer of a large refrigerating plant in which I was chief operating engineer.


3" BYPASS LINE
A
155 LB. PRESSURE-150° SUPERHEAT FROM HEINE BOILERS
MAIN #1 TO COMPOUND ENGINE
EXTRA HEAVY STEEL FITTINGS ON MAIN AND BYPASS
B
SAFETY VALVE BLOWS AT 115 LB.
C
D
FROM H.R.T. BOILERS-SAFETY VALVES 115 LB.
105 LB. SATURATED STEAM MAIN #2 TO SIMPLE CORLISS ENG
CAST-IRON FITTINGS

PIPING CONDEMNED BY INSURANCE INSPECTOR

Referring to the sketch, two steam mains are noted, No. 1 main coming from a Heine boiler having a Foster superheater carrying a steam pressure of 155 lb. and 150 deg. of superheat, furnishing steam to a high efficiency poppet valve compound condensing engine. The fittings on this main were extra heavy steel. Steam main No. 2, coming from a battery of horizontal return tubular boilers, had cast-iron fittings and carried 105 lb. of saturated steam.

The proposition was to bleed main No. 1 into main No. 2 through a 3-in. bypass line, using globe valve B as a reducing valve, valves A and D to be wide open, thus letting in some superheated steam into main 2 going to the Corliss engine.

The safety valve, C, on the bypass line was set at 115 lb. as were the safety valves on the boilers connected to main No. 2.

The insurance inspector condemned the installation, saying that the fittings on No. 2 main were cast-iron and not fit for superheat, and while No. 2 main was protected from over-pressure by the safety valve on the 3-in. bypass line, wiredrawing steam through a partly open globe valve between two mains coming from high pressure boilers was poor engineering and a boiler should be either cut in or cut out. And, furthermore, the seat of valve B would be cut to pieces in a short while by the superheated steam.

The mechanical engineer claimed the installation was all right, as the 105-lb. main was protected by the safety valve in the bypass line and superheat up to 80 per cent was all right in cast iron. As for having the valve B partly open and wiredrawing the steam from main 1 to main 2, it was no different from passing ammonia from the high to the low pressure side of a refrigerating system through an expansion valve.

F. M. McCobb.

Determining Polarity of a Wire

In electrical work it often becomes necessary to determine the polarity of wires carrying electric currents. This may be done by the use of a polarity indicator, an instrument which may be purchased at any electrical supply house and which indicates the polarity of a wire by the coloring of a liquid around the electrodes. These are available for use with either of two ranges of voltage: one type suitable for use on circuits varying from 0 to 50 v., while the other is for use on circuits of from 50 to 600 v. A portable voltmeter may also be employed for determining polarity if one is available.

Should neither of these instruments be available, however, the following home-made apparatus will serve equally well: Suppose it is desired to charge the storage battery shown in the accompanying diagram. Before

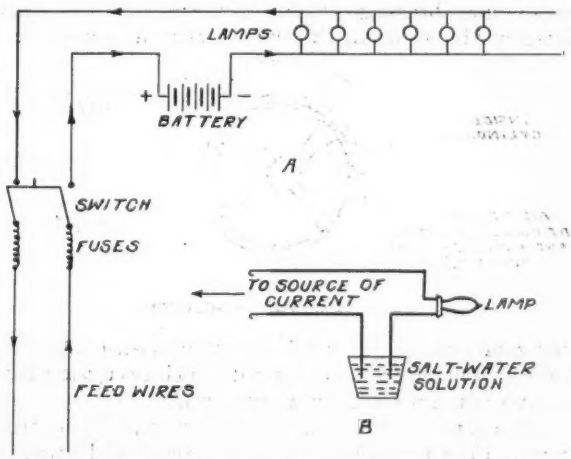


DIAGRAM OF CONNECTIONS FOR DETERMINING POLARITY

closing the switch it will be necessary to determine the polarity of the wires in order that the current will flow in the direction shown by the arrows.

Secure two pieces of wire of suitable length and connect a lamp into one of them as shown in the small sketch at B. Scrape the insulation off of the ends and place them in a tumbler or other glass receptacle filled with salt water as shown. Bend the other ends of the wires into hooks so that they may be hooked to the knife blades of the switch. It will be found that bubbles of gas rise from the ends of the conductors immersed in the salt solution, much more rapidly from one than the other, however. This one is the positive wire and the one from which the least bubbles arise, the negative.

John C. Kahl.

A Friction Heater

RECENTLY I happened to stumble on what, to me, is a new heating apparatus called "The Wonderful Friction Heater," invented by a Mr. Baker.

On inspecting an apparatus designed for a six-flat building, I found it to be an insulated drum about 4½ or 5 ft. long and about 30 or 32 in. diameter, with two cast-iron rings riveted on the ends and braced longitudinally. Another cylinder of smaller diameter was riveted to the inside edge of the ring, forming an annular space into which gas or liquid to be heated was allowed to enter. The machine from the open end looks like Fig. 1. Two more cast-iron heads are provided for a smaller cylinder with bearings for shaft inside the cylinder, which has three wooden pulleys attached over which is stretched a covering about 1 in. thick, made of coarsely woven hemp, a small air gap being between it and the cylinder wall. In the smaller sizes, this covering and pulleys are replaced by a solid wooden core.

To the shaft of the six-flat heater is coupled a 15-hp. motor at 600 r.p.m. The external appearance of the whole machine is something like Fig. 2. Now to quote the inventor, "The device is for extracting the latent heat from the molecules of the metal and to use said heat for the purpose of superheating gas or liquids and for the further purpose of providing a superheating union for raising the temperature of liquids or gases." Quoting further the theory of the machine is, "The revolution of the core heats the cushion of air inside the cylinder, which in turn excites the molecules of the metal, thus throwing off the latent heat before lying dormant in the metal, thereby heating the water and

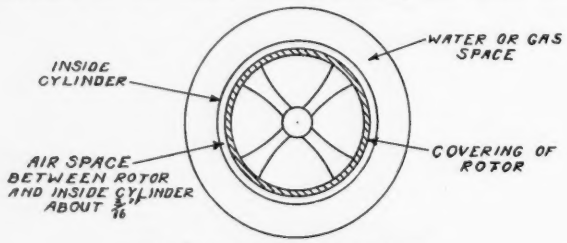


FIG. 1. END VIEW OF HEATER

producing steam. It is not contrary to science, but the A B C of science properly applied, which scientists have not up to the present given to the world."

The claim of the inventor that work is done by the rotor on the air cushion and that the heat will be transferred to the metal wall of the outer cylinder is, of course, correct; but when he states that "the molecules of the metal throw off latent heat heretofore lying dormant in the metal," it appears to be resurrecting the old caloric theory which ascribed the manifestation of heat to a subtle, imponderable fluid permeating all substances and that the heat of friction was some of the latent caloric ground or squeezed out of the body and become sensible, which theory was refuted first, I think, by Rumford in 1780 or thereabouts. As this theory was thrown in the discard by scientists 140 yr. ago, all we have to fall back upon to explain the production of heat by the machine is friction. Even if metal in a solid state did contain latent heat, imagine the immense quantity necessary in this thin cylinder, which is about 3 ft. long by 14 in. in diameter, necessary to heat six flats for 10 yr., which is guaranteed.

Taking, therefore, friction as the present-day scientific explanation of the heat-producing properties of the machine, we must allow, in figuring the cost of heating, a loss of 13 per cent in the motor, then friction loss at bearings according to their condition and lubrication, which would probably be large on account of neglect.

As we would have to pay for current supplied, I cannot see where the saving to the user would result.

The first cost would be, I think, as much as a hot water boiler and more than a furnace. While the labor required would be more for a furnace, it would not count in such a small installation and even with coal as high as at present it seems that the hot water system or furnace would be less costly.

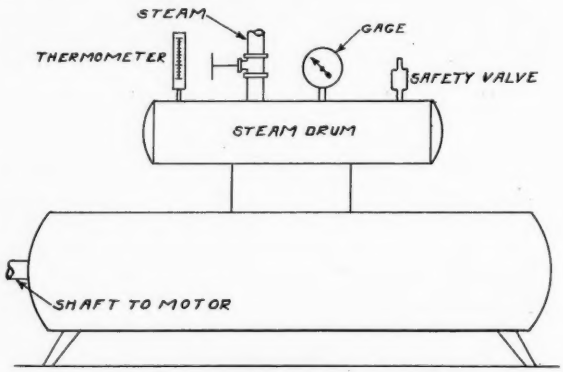


FIG. 2. SIDE ELEVATION OF HEATER

I have no doubt but some people with small buildings will install this machine and if I am right in my deductions, engineers understanding the subject, in case they gain knowledge of such intentions, ought to explain the matter to them. The machine is being shown in the basement, 101 So. Water St., Chicago.

WM. CHIDDICK.

Repairing Cracked Cylinder Liner

SOME TIME AGO we had a cylinder liner crack on one of our horizontal Diesel oil engines. This crack occurred where the skirt of the liner fits the frame and extended around the diameter about 15 in. As it was imperative that this engine be kept running for two or three weeks longer, we shut down only long enough to take care of the water leaks in the lubrication oil the best we could and kept the unit on the line until we were able to secure a shut-down. When the crack was first discovered, it was about 6 in. long and in three weeks had lengthened to 15 in.

Pulling the piston, we drilled and tapped out for ⅜-in. plugs the ends of the crack, then following along the crack and lapping each plug, we drilled, tapped and plugged the entire crack, using ⅜-in. plugs altogether. In drilling the plug holes, we drilled through the liner to the rubber packing ring where the skirt of liner fits the frame. After all plugs were trimmed off flush with inside surface of liner I took a small peen hammer and peened all plugs down smooth and went over the surface with a carborundum stone and polished it up. Turning on all water pressure we could get, about 20 lb., no leak showed up inside, but we had a small leak outside the liner which plugged itself after the engine heated up and has never shown up since.

We have tested this out several times since and have never been bothered. Last week I repaired another and this crack was 20 in. long and we had the same good results. It was a tedious job but well worth the time and trouble when you figure the cost of a new liner and the job of pulling the old and fitting the new one.

CY LINDER.

Packing Friction

UPON READING the articles by A. C. Waldron in the July 1 issue and LeRoy D. Kiley in the Sept. 1 issue on the subject "Packing Friction," I note that both of these gentlemen have overlooked the "stopping time method" of determining packing friction.

It is true, as Mr. Kiley points out, that what is wanted by most engineers is the "friction of motion" and not the starting friction because it is the friction of motion that eats up the coal pile. Starting friction is the greater of the two, but it doesn't last long.

The friction of motion can be obtained by using an indicator with a very delicate spring. The motion of the spring must be restricted, of course, to the load under observation and must not be permitted to travel to extreme limits, or the spring will be ruined. The way to make the test is to run the engine at normal speed without any load on it at all and take an indicator card. The card will give the horsepower required to run the engine "empty" with the old packing, say, screwed up tight.

Then remove the old packing and replace it with new, in the usual way, making it just tight enough to prevent leakage, and take another indicator card. The area of the diagram will very likely be less. It should be less, but the difference may be so small that the spring will not detect it. Much depends upon the delicacy of the spring, and of course a great deal depends upon the difference in packing friction. In refrigerating machinery having long stuffing boxes, the difference in friction may be so great that even a stiff spring can detect it. By subtracting the horsepower of the smaller diagram from the horsepower of the larger, the horsepower unnecessarily consumed by the old packing is readily determined and the cost of keeping the old packing in place can be computed.

The "stopping time method" is usually more delicate and can be applied to turbines and motors as well as to engines. In using this method, take out your watch and on closing the main steam valve or on throwing the switch, make note of the time required for the engine, turbine or motor to come to a dead stop. The quicker the stop the greater the friction that causes the stop. The slower the stop the less the friction. If there were no friction the flywheel or rotor would continue to run forever.

By taking the stopping time with the old packing in place and then with the new packing in place, and noting the difference in stopping time, you have a measure of the friction of the packing. Care must be taken, in making the change, to alter the packing only. The engine must not be lubricated or adjusted in any other way. This applies to the indicator method as well as to the stopping time method.

It is possible to compute the horsepower difference, using the stopping time method; however, the engineer is usually satisfied after simply making the test. If he knows that the stopping time is the same day after day, all other conditions being the same, he likewise knows that there is no appreciable difference in packing friction.

Both of these methods give the desired "friction of motion."

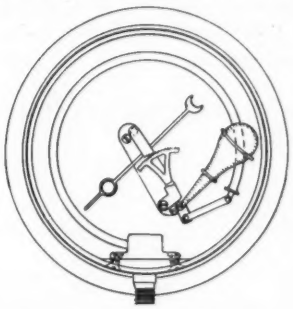
N. G. NEAR.

ON PAGE 871, Sept. 1 issue, Mr. Kiley, in criticizing my article on "Packing Friction" which appeared in the July 1 issue, brought out some interesting suggestions in regard to packing friction, referring especially to the inertia as affecting the ultimate result of such tests; but the inertia effect, of course, will require the tests be taken while the engine is in its normal running condition, and if this was done there is a possibility that the 753 lb. of dead weight pull might result differently.

A. WALDRON.

Handling Small Gage and Meter Parts

IN REPAIRING pressure or vacuum gages, small parts such as sprocket frames and pinions are not readily handled by one not accustomed to such work; yet it is often necessary to do a great deal of this work. Tweezers are not very practical as the small parts easily slip from them and they are more or less difficult to handle.



SHOWING THE USE OF A SMALL SYRINGE IN ASSEMBLING GAGE PARTS

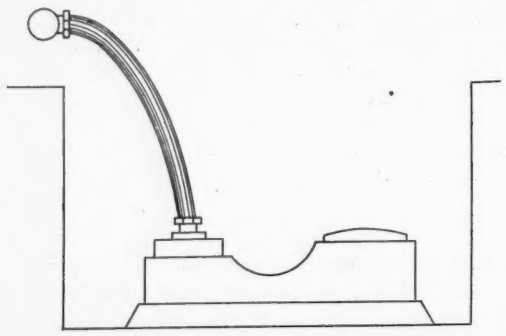
The sketch shows how an ear or ulcer syringe can be used very practically in this work. The rubber tip is cut off at a slight angle with a sharp knife, and is touched to the light parts after the air has been excluded from the bulb. They will be firmly held and the nipple end is rigid enough to allow the parts to be dropped or laid in place with the fingers out of the way. This permits the hand to be steadied on the edge of the gage casing. The light screws can be worked from the end of the driver then without half the trouble, but two sets of fingers down in a close place cannot do a great deal to any advantage. A small new syringe can be bought for 15 cents, and is a saver on nerves. The syringe is also practical for assembling a great many other small light parts.

FRANK W. BENTLEY.

Emergency Connection to Pump

WE HAD in service a boiler feed pump which it was necessary for us to locate down in a pit in order to insure the proper head to handle the hot water, and after many years of service we had it removed over the week-end to be re-lined and generally overhauled—the idea being to have it back in place late on Sunday, or in time for the Monday load. As is often experienced in overhauling work, more things had to be replaced and fixed up than we contemplated, and the pump was not

delivered back to the plant until about nine o'clock on Sunday night, after we had all put in a strenuous day and were pretty well tired. The re-location of the pump, which involved turning it in the opposite direction, in order to provide room for a spare pump which we were getting, necessitated some changes in piping



STEAM HOSE MAKES TEMPORARY PUMP CONNECTION

which also required pipe cutting and fittings. At that hour none of us were in the humor for doing this work, and one of the men suggested "why not hook 'er up with some of that flexible boiler cleaning hose." We followed the suggestion, merely running a length of

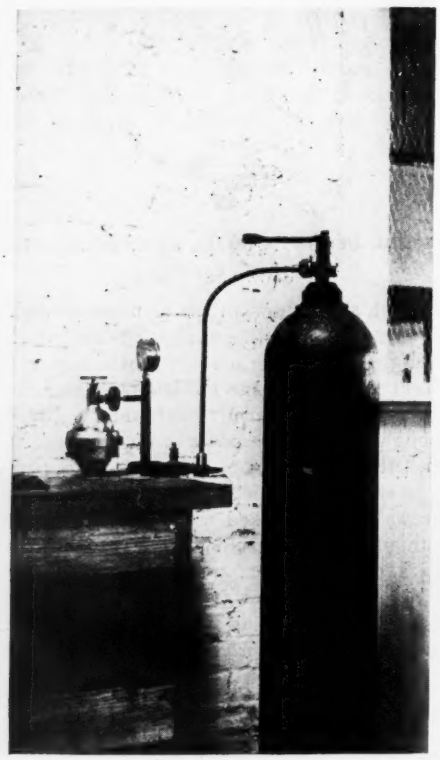


FIG. 1. OXYGEN CYLINDER CONNECTION

hose from the steam line to the pump inlet and in 15 min. we had the pump under steam and in service without any need for tedious pipe work.

We operated the pump with this hose connection until the next weekend when we completed the job under less trying conditions. M. A. SALLER.

Fitting for Oxygen Tank

HEREWITH are a photograph and two drawings showing details of a special fitting which we made for connecting a large oxygen tank to our Emerson fuel calorimeter set. We have been handicapped here in using the small cylinders supplied with the calorimeter, as when one cylinder was exhausted we had to send it several hundred miles for a new charge of oxygen. The large cylinder, however, can be obtained locally and recharged for about $6, while the small cylinders cost $2 for each recharging and in addition we must pay for the express.

The two fittings shown in detail are connected with ordinary ⅛-in. iron pipe. A piece 21 in. long threaded at each end was connected to the two fittings and bent to suit the height of our bench as shown in the photograph. By connecting the bomb with its valve closed to the end of the yoke, it is a simple matter to recharge the small cylinder or we could charge the bomb directly, but as a rule we have been recharging the small cylinder

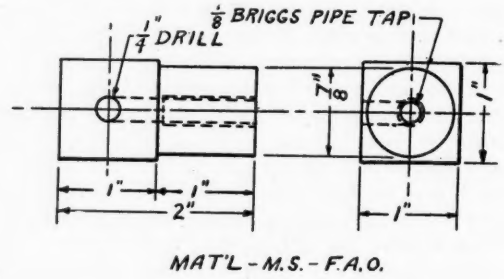


FIG 2

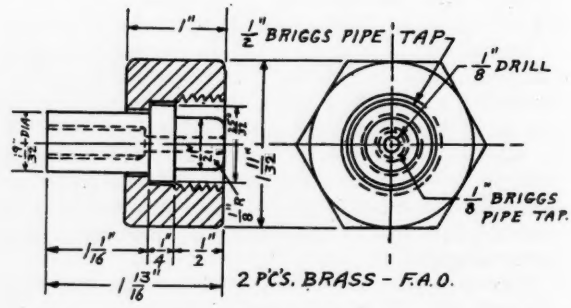


FIG 3

FIG. 2. FITTING ATTACHED TO BENCH
FIG. 3. FITTING ATTACHED TO CYLINDER DISCHARGE

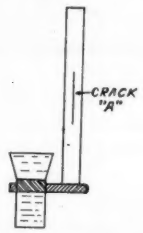
and then charging the bomb from the small cylinder. In this way, the single charge in the large cylinder will last us over a year and saves considerable trouble as well as money. The large tank is a standard 200-cu. ft. Linde oxygen cylinder. WM. JAY DANA.

Why the Rubber Ball Flush Valve Leaked

IN MANY plants, the engineer in charge of the power plant has also to take care of and do the repairing on the plumbing work throughout the factory; for this reason I thought that the following experience might benefit some of the readers.

Some time ago I had a plumber repairing a number of water closets in the factory. With one closet in particular he had great difficulty in preventing the rubber

float valve from leaking. A number of new and different sizes of rubber balls were used, but the valve still leaked. It was then thought that perhaps the valve seat was cut, but examination showed that this was not the trouble. After working on the valve for a number of hours, he finally discovered that the part on the valve shown in the illustration was cracked as indicated at A, which caused



RUBBER FLOAT VALVE FOR LOW CLOSET TANKS

the apparent leaking of the valve whenever water came up to this crack. The water would run through the crack into the closet when it was thought that the valve leaked. After this crack was soldered up the trouble disappeared immediately.

H. A. JAHNKE.

Experiment with a Turbo Blower

MANY TIMES we try things, some of which attempts are unsuccessful, yet we do not feel that the time spent on them has been wasted. While several experiments may prove useless, another attempt along the same lines but just a little bit different, proves successful and then we feel repaid for all the former unsuccessful trials.

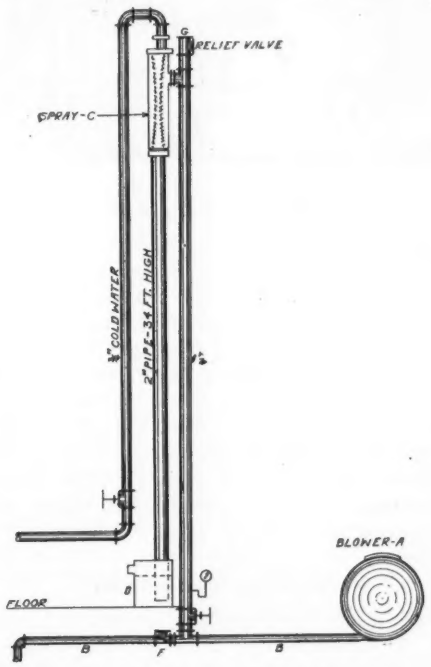
In one case I had a 20-in. turbine blower used for forced draft in the ashpit of a furnace burning eight parts of screenings to one part of soft coal. This blower would maintain 1¾ in. of draft in the ashpit. The exhaust from this turbine blower used to go in with the air but it was found that after a short time the fire would become soggy near the grates, so the exhaust was finally led outside of the boiler room.

It seemed to me that this blower could run condensing, so I piped it up as shown in the sketch, the exhaust pipe being indicated at B, B. I installed a swing check having a weighted arm at F, also one at G.

For my first water spray I employed a common garden hose end and installed it so that it sprayed the water into the exhaust steam inclining downwards. This was placed at C.

I found, however, that I could get but 10-in. of vacuum and then it wouldn't hold long. I knew that there must be a leak somewhere, or that the jet was not made tight, so I took a ¾-in. pipe, 6 in. long and sawed it out crescent shape as shown at C, in order that the water would drag in the exhaust steam by its velocity and form a vacuum. This arrangement was no better than the first method, so I determined to find out whether such a turbine could be run condensing, and upon examination it was discovered that if a vacuum is created in the turbine, it will draw the oil out of the oil chamber and destroy the bearings. I proved the latter fact after plugging a vent hole which was left in the chamber presumably for the purpose of preventing the formation of a vacuum in the casing.

This, then, was the reason for the failure to hold the vacuum, and while it seems like a lot of trouble to go to, to demonstrate the fact in this manner, experiments are



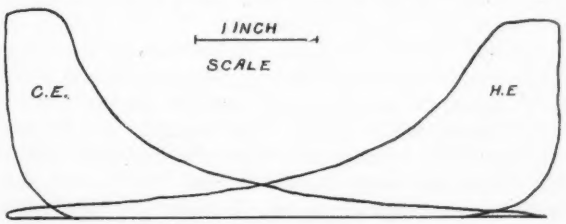
HOME MADE CONDENSER FOR TURBO BLOWER

interesting and now and then they prove profitable. The turbo blower is made by a company at Worcester, Mass.

A. WALDRON.

Obsolescence Deferred

WITNESS THE indicator diagram shown herewith. It is an almost perfect Corliss card. The expansion line deviates from the theoretical hyperbolic curve by only a small fraction of an inch. The card was taken from a 14 by 36-in. Sioux City Corliss engine at Fremont, Neb., running at 100 r.p.m. under a boiler pressure of 120 lb. per sq. in. gage, and atmospheric back pressure.



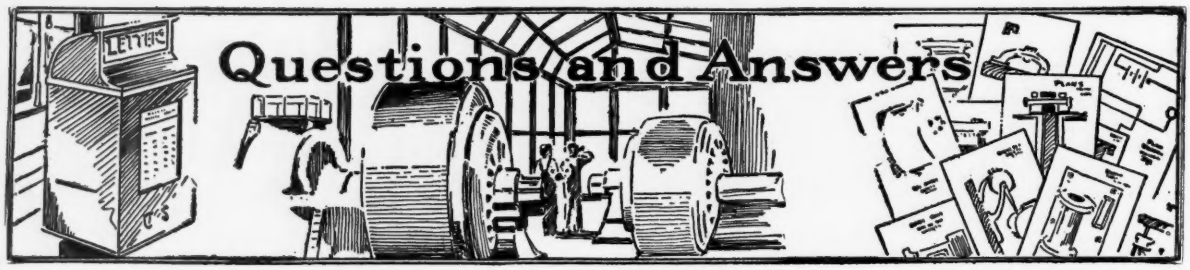
INDICATOR CARD FROM A SIOUX CITY CORLISS ENGINE

Cutoff occurs at about 14 or 15 per cent and under these conditions the engine operates on a mean effective pressure of 54 lb. per sq. in. and develops 75.5 i.hp.

This engine is 35 yr. old and has not been rebored in the last 13 yr., and it still puts forth its quota of horsepower on an average of 15 hr. per day.

The card was submitted by C. E. Haines.

THE MOST valuable "system" is a good nervous system.—Forbes Magazine.



Crank Case Leak

WE HAVE a two-cylinder, compound, vertical, forced lubrication engine with enclosed crank case, which holds about ⅔ bbl. of oil. Every few months the crank case leaks oil on the floor. There are no cracks or anything in the case, but it seems to be the pores of the metal that are at fault. Can someone tell me how I can cure this fault? I have only 7 hr. to do anything in, as the unit must run for light and water. As a temporary job, I am putting axle grease on the bottom of the case, but have to renew it every three months. During the time the engine is idle, it is warm and the oil is hot, so any cure must act quickly. L. C.

Condenser Capacity

I HAVE a condenser problem on which I would like advice. The condenser is 12 by 20 by 24-in. horizontal, jet, and has a valve area of 17 per cent of the piston area. It is connected to two 13 by 23 by 17-in., 225-r.p.m. piston valve engines. Indicator cards show a total load of 250 i.hp. from both engines. The injection water is 115 deg. F. with a discharge of 137 deg. F., vacuum 15 in. and piston speed of condenser 76 ft. The injection water comes under 8 ft. head and discharges against 38 ft. head. I am unable to get more than 15 in. vacuum and would like your opinion as to what must be done to get more. It looks to me as if the condenser was too small. While the piston might be large enough, the valve area at 76 ft. piston speed gives a velocity through the valves of 450 ft. Allowing 20 lb. steam per i.hp. hr. at 250 hp., there would be required about 53 lb. water per lb. steam at 120 deg. injection and 26 in. vacuum, which would require about 560 g.p.m. and allowing 30 per cent more pump displacement for air and vapor, would make about 700 g.p.m. With a water velocity of 200 ft. per min. through valves, the piston speed would be 34 ft. and the piston displacement at that speed would be 560 g.p.m., which I claim is not enough. A condenser catalog which I have states that the discharge should not be elevated more than 2 ft. and if it is necessary to do so, use a separate pump. I cannot see what difference that makes if the steam cylinder is large enough to elevate it. I do not like to see injection under a head, but fail to see why that should affect the vacuum. It will of course affect the vacuum breaker. G. L. J.

Smoke Abatement

I WISH to submit the following for the consideration of E. H. S. in response to his query regarding smoke abatement, on page 927 of the Sept. 15 issue.

I have tried many devices for eliminating smoke in furnaces burning bituminous coal and have found that where steam jets have been used or where air has been admitted at the side walls, through the firing doors or above these doors by the means of openings the efficiency of the unit has been lowered and in many cases has not stopped the smoke.

In firing a furnace burning bituminous coal, it is necessary to have the furnace of such size that the air entering the fuel bed at the bottom and top will have time to mix thoroughly with the gases so as to have them burned completely before they come in contact with the heating surface of the boiler or cooler brick work of the setting. The air which is admitted over the fire should come as close to the top of the fuel bed as possible in order that it may be heated to a temperature close to the ignition point of the gases. This cannot be accomplished by admitting it through the fire doors or dampers in the front of the boiler, as the air will pass into the furnace in streams and will not be properly mixed, but will come in contact with the heating surfaces of the boiler which will lower the efficiency of the unit.

E. H. S. does not state what kind of furnaces and boilers he is operating, but it is most likely that his trouble is either from lack of combustion space or draft. If it is the former, he can eliminate a high per cent of the smoke issuing from the chimney by installing a depression plate at the front end of the furnace, back of the dead plate, this will lower the grates and allow the air to be admitted at the surface of the fuel bed over the whole width of the grate, which will give an even distribution of oxygen to the gases as they are thrown off from the fuel. I have had good success with these plates under boilers which are not equipped with brick arches. There will be times when there will be too much air admitted unless the depression plate is equipped with a damper to regulate the supply. When too much fuel is fired, the temperature of the furnace and air will be lowered and will cause smoke. It is not impossible nor is it difficult to eliminate smoke, when the furnace is anywhere near being of ample volume and the fireman does his part to try to have a smokeless chimney.

Arches can be placed in the furnace or back of the bridge wall to prevent smoke, but I have found these to be more of a detriment than a help. My opinion, from experience, has been that the furnace which is equipped with the inclined grate, whether front or side feed, without arches over the fire gives the best results in the burning of bituminous coal with the least smoke, in hand-fired furnaces. CHAS. J. MILLER.

IN REPLY to E. H. S., Sept. 15 issue, I submit the following information gained from my own practical experience with the device described, which is due to A. E. Wolcott. The device is simply a steam jet, the

nozzle of which is fan shaped, having small holes on its periphery. This nozzle is placed in the front wall above the firing doors and so directed that the line of the jet reaches to the bridge wall at the grate surface. It works equally well with brick settings, Scotch boilers, B. & W. or locomotive boilers. Its function is to mix thoroughly the gas and air and thus facilitate combustion. R. G. S.

In reply to E. H. S.'s question on smoke abatement: I am firing a battery of B. & W. boilers with Murphy smokeless furnaces and stokers. Each boiler is equipped with a Blonck draft gage. By cutting down the number of inches of draft through fire and also to stack, I find that very little smoke, if any, comes from the stack. In order to do this, I keep about a four or six-inch fire and set the damper in stack so I obtain anywhere from one to two inches of draft through the fire and from fire to stack.

It may be that E. H. S. has air holes in his boiler settings or leaks in the baffle wall, which would cause smoke. C. A. Sackett.

Answers to Examination Questions

On page 824 of the Aug. 15 issue, C. E. R. asks: What is the best method to start a direct connected compound condensing engine?

The method will depend largely on the piping of the condenser, the exhaust piping of the engine, and other conditions existing in each individual installation. With a 500-hp. Corliss, having the bucket pump of a jet condenser connected to the crosshead of the low pressure side of a jet and having no outport exhaust pipe, the condenser being in the basement below the guides, our procedure is to get the engine oiled up, set the valves on the high and low pressure sides so steam will blow through and open the throttle just enough to let steam simmer through to warm up the cylinders. The steam blows through to the condensing chamber up through the suction bucket, and delivery valves, and out through the discharge pipe. When the cylinders are warmed up, shut the throttle valve and open the live steam valve to the condenser chamber so as to heat the condenser chamber. Then shut off the steam valve and open the injection water valve on the condenser chamber. This will condense what steam is in the condenser, and the water passes out through the suction bucket and delivery valves by gravity. This valve must be immediately closed again—just opened and closed. There will be thus created about 4 in. of vacuum in the condenser chamber. Now open the throttle valve and admit just enough steam to start the engine for a turn or two then close it again, open the injection valve on the condensing chamber as the engine is turning. The bucket pump is now moving and is building up a vacuum in the condenser chamber, and the throttle valve can then be opened enough to allow the engine to run slowly while the vacuum is building up. When there is sufficient vacuum to lift the condensing water into the chamber, open the inlet, condensing water supply valve just enough to admit sufficient water to condense the steam and close the forced injection valve and gradually speed up the engine. As the engine is coming up to speed the inlet water supply valve can be opened slowly until there is sufficient water to condense the steam when the engine is fully loaded.

If it is necessary to slow down the engine, the inlet water valve must be throttled down also, because the bucket will be running slower and cannot pump as much water, otherwise the water would rush in and flood the condenser chamber, destroy the vacuum, and, if the load were light, the vacuum pulling on the low pressure piston would require less steam in the high pressure side to keep the engine moving. This condition is likely to create a vacuum in the receiver between the two cylinders, causing the low pressure side to act as a pump, which would pull the condensing water up through the condensing chamber into the low pressure cylinder where it would be trapped by the exhaust valve closing for compression. On the return stroke of the piston this slug of water would cause the cylinder head to be knocked out. When stopping the engine the throttle valve is closed first and then the inlet water supply valve. The energy stored in the flywheel will keep the engine turning long enough to expel the water from the condenser and then any leakage of steam past the throttle valve would be drained out of the receiver as condensate, through the receiver trap, or if carried over through the low pressure cylinder, would be carried as condensate or vapor through the condenser. If the valves on the steam cylinders cannot be blocked partly open on both ends of each cylinder at the same time, then the wrist plate must be rocked to open them separately for short periods until the engine is warmed up. If there is an outport valve on the exhaust pipe and a stop valve between the low pressure cylinder and the condenser, then the engine can be warmed up by closing this stop valve and allowing the exhaust steam to escape through the outport valve to atmosphere. The engine can then be started, non-condensing until there is sufficient vacuum to lift the water into the condenser, when the inlet water supply valve can be opened and then the stop valve between the engine and condenser chamber can be opened slowly. The outport valve will be closed automatically by the vacuum pulling it shut and the inlet water supply can then be regulated to the amount needed to carry the full load on the engine.

A shop inspection should consist of witnessing the tests of the different test pieces of plate and braces for tensile strength and to see that they contained the properties as the law requires; also the testing of rivet rounds for shearing strength, and the examination of all parts after made, and while the boiler is being constructed. When completed it should be examined internally and externally for defects in metal or workmanship before the hydrostatic test is made. After this test, the boiler should be again examined internally and externally to see that no braces or stays have been broken or fractured by the test or that any plates have developed cracks. This shop inspection is in accord with the laws of the state in which they are made to see that the laws are complied with as regards material and methods of construction.

Why is it that the state of Michigan does not approved of externaly fired boilers of greater diameter than 84 in.?

While the state of Michigan may not approve of the use of externally fired boilers over 84 in. diam., that does not imply that a boiler of this diameter or larger cannot be used and externally fired. But few insurance companies wish to accept risk on such boilers. The state of Massachusetts requires all boilers 78 in. or over in diameter to be supported or suspended independently from the brick setting when externally fired. The principal objection is that the thickness of the lapped plate at the girth seam being exposed to the direct action of the fire is likely to be burned. For illustration, a boiler 8 ft. in diameter would have, if high pressure is desired, ⅞ or 1-in. plate and lapped at least 2½ in. at the girth seam, which would mean a band of metal 2½ in. wide by 2 in. thick over the fire. Then with 1 in. rivets, there is added to the thickness of the two 1-in. plates the thickness of the two heads of the rivets, which makes the thickness of the plates and rivets over 3 in. Even if there were no scale formation on the inside of the seam, the water could not absorb all the heat delivered to the rivets and plates through such thickness and the rivets and plate would be burned and weakened.

For this reason some insurance companies allow risk on such boilers suspended independently of the brick setting. If the boiler plate has been shaved down at the girth seam joints to ¾ in. thickness. The lap of two such plates and the 15/16 in. rivets used makes a girth seam joint as thick as is considered safe to be exposed to the direct action of the fire.

Boilers are used and externally fired 84 and 90 in. in diameter in the United States, and in some countries as large as 110 in., but this is not approved by the laws or insurance companies. Boilers are used in various large diameters when internally fired, as there are no thick riveted joints exposed to the direct action of the fire. R. A. CULTRA.

Belt Speed

THE ANSWERS to the questions under the heading Belt Speed on page 827, Aug. 15 issue, are, we find, somewhat confusing and a little further explanation may be of aid to some readers.

It is assumed in answering the first question that J. W. W. wishes to know whether or not his belt is running at the proper speed for its breadth and thickness and the horsepower it is transmitting. For finding the actual speed in feet per minute, multiply the diameter of either pulley in feet by 3.1416 and this product by revolutions per minute of the pulley. Now, the rule of thumb given by Nachman for belt operation is that the horsepower transmitted is equal to the breadth in inches times the velocity in feet per minute divided by 800 for a single belt or by 500 for a double belt. Expressed as a formula, this becomes: hp. = b × v ÷ 800; or transposing v = hp. × 800 ÷ b.

If the velocity as given by this formula is considerably higher than the actual velocity, the stress in the belt is most likely greater than is recommended in good practice and the diameters of the pulleys should be increased, the speeds of the shafts remaining the same, until the actual and calculated velocities are reasonably close together. This formula, therefore, gives a check upon the correctness of the installation.

In the answer to question No. 2 it should have been stated that there is practically no gain in power by changing, as suggested, the ratio of pulley diameters, in other words, the efficiency of the belt drive is neither increased nor decreased any appreciable amount by the change in pulley diameters suggested. If, however, J. W. W. wishes to know whether or not his belt will be capable of transmitting more power with a different ratio of pulley diameters, the application of the formula given for horsepower in answer to question No. 1 will answer the question. EDITOR.

Scored Pump Cylinders

I HAVE observed with interest E. G. M.'s account of his boiler feed-pump troubles on page 824 of the Aug. 15 issue and from the explanation he has given I am of the opinion that his troubles may be caused from all or some of the following causes: The new brass lining sleeves may be made of too soft a material or otherwise not as good as the ones he took out, or the packing used might be too hard, and when placed might swell from being packed too tightly, causing it to gouge into the sleeves.

I would recommend, not a hydraulic packing for this purpose, but a good boiler feed, hot water packing that would withstand 212 deg. F. As he states that there is no grit nor scale in the water to cause this trouble, it could be possible that there may be some sort of galvanic action which is causing the water to attack these brass liners.

In regard to equipping these pumps with solid metal pistons and snap rings, I am inclined to think that more practical results in that respect could be secured by placing new brass liners and solid cast-iron pistons and omitting the snap rings. If he has no grit or galvanic action to contend with and where a first-class job is obtained, he should get results from these pumps. H. W. ROSE.

Which Water Should Be Used?

WE ARE using, at our mill, here, six 250-hp. return tubular boilers, set in steel casings.

We are having considerable trouble with the water from foaming or lifting and will appreciate your advising us if this trouble can be corrected or improved upon by the water we have available.

We are using exclusively the water from well at Jedburg as per analysis 50,031 given below. As you will see from analysis, this water is soft and would be expected to foam, especially if the boilers were fired hard.

The other water we have available in a limited quantity is from Bay well as shown by analysis 50,047. This is a hard lime water and while we realize it would scale if used alone, it occurs to us that if this water could be mixed with the Jedburg well which we are now using exclusively, that it might help the foaming trouble that we are now having.

About what percentage of each water should we use to get the best results? F. P. P.

Jedburg well analysis No. 50,031:

Total solids	470 parts per million
Equiv. to 27,409 grs. to U. S. gallon.	
Magnesia	4 parts per million
Hardness	14 parts per million

The solids consist chiefly of carbonate of soda with a little lime probably as chlorides. The water contains also a small amount of organic matter.

Bay well analysis No. 50,047:

Total solids .....190 parts per million
Equal to 11.08 grains to U. S. gallon.
Hardness ..... 72 parts per million

Total solids consist of carbonates of soda and the alkaline earths (lime and magnesia) with some sulphate and a little chloride.

A. The analysis submitted is far from complete. It gives only the total solids and the hardness, and we, therefore, have no means of knowing exactly how much sodium carbonate the water contains.

We could not recommend using the Jedburg well water for the reason that it contains a much higher sodium carbonate content than the Bay well. The total solids of the Bay well are 190 parts per million, equal to 11.08 grains per U. S. gallon. The hardness of the Bay well is 72 parts per million, equal to 4.2 grains per U. S. gallon. This leaves a sodium content of 6.88 grains per U. S. gallon.

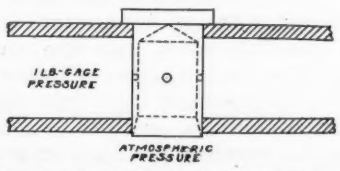
We are familiar with plants using water tube boilers where this amount of sodium carbonate is handled without priming or foaming troubles. They would certainly be much less liable to foam or prime on the Bay well water than they would on the water from the Jedburg well and if the hardness contained in the Bay well proves to be objectionable it would be easy to remove the hardness by softening.

We would not advise the use of the mixture of both waters because by mixing you would necessarily have a higher sodium carbonate content that is present in the water from the Bay well, and sodium carbonate is the trouble maker. F. F. VATER.

Flow of Air Through an Orifice

CAN YOU give me any information relative to flow of compressed air through an orifice?

What I desire is size of orifice to pass 35 cu. ft. of compressed air at 1 lb. gage pressure into a cylinder through a hollow valve by means of small holes, as shown in the sketch.



ARRANGEMENT OF HOLLOW PLUG IN CYLINDER WALLS

I cannot find any formula that will give me the necessary information and hesitate to use Napier's, for flow of steam.

I think the exhaust air will be at atmospheric pressure and you can assume that. If possible, give me data that will enable me to calculate size orifice if exhaust is only slightly below source. H. A. A.

A. In determining the size orifice required to pass 35 lb. of air from a region of 15.7 lb. pressure to atmospheric pressure, we resort to Fliegner's equation; Napier's equation is not applicable:

$$M = 1.06\ F \sqrt{p_a\ (p_1 - p_a) \div T_1}$$

where M is the flow in pounds per second; F, the area of the orifice in square feet; p_a and p_1, the initial and final pressures in pounds per sq. ft., and T_1, the absolute temperature of the air at pressure p_1.

Since you do not state the time in which this amount of air is to be discharged, we will assume one minute. We will also assume the temperature as 70 deg. F., or 530 deg. absolute. At a temperature of 70 deg., 1 lb. of air has a volume of 13.34 cu. ft., and consequently 35 cu. ft. will weigh 2.62 lb. Substituting these values in the above equation, we get

$$2.62 = 60 = 1.06\ F. \sqrt{[144 \times 14.7 \times (15.7 - 14.7) \times 144 \div 530]}$$

from which, F = 0.0437 ÷ 25.4 = 0.001,72 sq. ft. = 0.247 sq. in., from which, the diameter of the hole is found to be 0.55 in. If you wish to discharge 35 cu. ft. per hour instead of per minute, the diameter of the hole would be 0.0723 in.

Where Should Flowmeter Be Installed?

WILL YOU kindly advise me what plan you would recommend for measuring feed water between heater and pump? If flowmeters are accurate, how would you take care of an installation for hot water, on the suction line? A. G. S.

A. It is not usually to be recommended that flowmeters be installed on the suction side of a pump, the reason for this being that the flow is not steady and it is a difficult matter, therefore, to calibrate the meter to give accurate readings.

If it is your intention to use either a venturi, pitot tube, or orifice meter, it would probably be best to put this instrument on the discharge side of your pump if it is possible where pulsations can be partially dampened out by an air chamber. If this is out of the question, we would suggest using either a weir or an actual weighing device on the suction side. This, of course, is only possible where your feed water is open to atmospheric pressure.

How Should This Boiler Be Fired?

IN THE Sept. 15 issue of Power Plant Engineering, on page 927, R. F. L. asks how to fire a particular Scotch type of boiler. In his question he has stated that he has tried all means of firing without getting results, and when using fine coal the best results were obtained by firing light and often, and using the hook or rake often in order to make the fuel burn. At other times, one side of the furnace will be bright and the other side will die down.

I do not think the firing or fuel has anything to do with the action of this boiler. The trouble probably is in the lack of draft, air openings in the grate being out of proportion or too small, and lack of space in the combustion chamber. The way to prove these suppositions would be to attach a draft gage to read the draft over the fire or if there is not a draft gage handy, turn on the blower and, at the same time, note whether the condition of the fire changes. Should there be no blower, attach a pipe or hose to some steam line and enter it in the uptake. If the cause is due to any of these defects this will show up on the fire by making it burn better.

CHAS. J. MILLER.

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Federal Taxation

In devising means to raise revenue for the Government, one thing is inescapable: They must produce the amount of money needed to pay the expenses of the Government, including the interest on its bonds. Obviously it is a part of putting "more business methods into government" to reduce expenses to the lowest amount consistent with proper carrying out of proper government activities; and the Budget Bureau under the active and able leadership of General Dawes is on its way to accomplish that result.

There remains the question of what sources and methods of taxation shall be employed to raise the essential revenue. Certain features of the tax bill of 1918, now in force, were war measures for extraordinary conditions and extraordinary revenue. They were probably justified at the time, but, at present, produce irritation, derangement of business and expense for collection out of all proportion to the money collected. Income taxes will have to remain, and properly adjusted are as fair a method of taxation as can be devised. But they should be levied with respect to fair adjustment to the taxpayer's benefit from government and his ability to pay, not as a penalty on ability or for political effect. If reduction is made for one class of incomes (unless the present tax is excessive), corresponding reduction should be made for other incomes, and corporations should neither be favored nor penalized.

Business of the country has expressed itself through a referendum vote to the Chamber of Commerce of the United States as favoring a sales tax to replace the present excess-profits tax, taxes on telephone and telegraph, and taxes on special lines of business. And the Treasury Department has also advocated these changes, part of which were promised by political leaders during last fall's campaign. It is agreed by everybody that the excess-profits tax has played havoc with business and prices, that it is now producing but a fraction of the revenue at first expected, and that it penalizes corporations which have been run on conservative lines without inflating capital or padding expenses. Collection of this tax has not been efficiently administered, and the Department is several years behind on its work of checking up reports. Yet Congress is now proposing to continue it for 1921, presumably because the courage and the ability to devise a substitute which will raise equal revenue are lacking. The question arises—Have we sent our best brains to Congress, and if we have why are they not working? If this tax, as stated by business men, Secretary of the Treasury and other experts is unjust and injurious, why continue it another year?

Two features of present tax administration work hardship to taxpayers. All contests or questions of tax levy must be carried to Washington, which generally means one or more expensive trips for the taxpayer, and are finally settled by officials of the department which collects the taxes, one party to the controversy. Obviously this is putting the taxpayer at a disadvantage so great that he may be obliged to abandon his rights, and certainly is unfair to those who live at a distance from the Capital city.

Another thing, revisions of taxes assessed are made years after the taxes have been paid, and retroactive rulings are frequently made which impose unexpected

burdens long after the individual or corporation has supposed the entire matter to be finished business. Certainly there is no justice in accepting payment in full; then long afterward demanding further payment which may involve burdensome complications, or conceding an overpayment which requires a considerable amount of red tape to reclaim, meantime withholding money that belongs to the taxpayer without giving him any compensation for the use of that money. Changes are needed in methods of administration to give the taxpayer security and justice rather than to give department officials an easy way of handling their work. These, like all changes of government methods, will take time, but should be pressed for accomplishment, since they involve the collection of taxes in whatever form they are levied.

From the present condition of the tax bill, it would seem that it has been framed as a matter of political expediency, in the belief that people throughout the country have no settled opinion as to what should be done, and will accept whatever is offered in dumb submission. It is high time that Congress learns the demand of the people that revisions be made which will take the brakes off from business, will distribute tax burdens equitably and will allow of prompt and business-like method of collection.

These things cannot be accomplished with the excess profits tax. They are practically impossible so long as there is a large and increasing volume of tax-exempt securities available. They are unlikely with discriminatory taxes on special lines of business. It is up to the taxpayers, individuals and business leaders, to make themselves heard in Washington with a demand for fair, sensible and prompt taxes, so that every man may get justice, may know where he stands when once his tax bill is paid, and may be able to judge, as he goes along, reasonably well what his taxes will be for the next year.

If we all keep still about this, Congress will play politics. It is up to us to convince our representatives down there that the best politics is to play fair with us folks who pay the bills and to give the country what it has asked for.

Refinements in Modern Plants

Our modern central stations without doubt are our best examples of what can be attained in the way of economy, and it is but natural that they should be, since their primary purpose is the generation and sale of energy. The high efficiencies obtained in these plants as well as in the larger industrial power plant is due to two things, first, to the larger size of the power generating equipment, and, second, to the employment of many refinements of operating practice.

These stations with their elaborate engineering departments and by virtue of the high class of technical skill available are able to reap the benefit of all the latest improvements and developments in the engineering profession.

While it is obvious that many of the economies due to the inherent higher efficiency of the large sized apparatus found in large stations cannot be obtained in the small industrial plant, there are, nevertheless, many refinements practiced in large plants which are just as applicable to the average small plant. What are these requirements? Progress in this direction has been so rapid that the engineer of the isolated plant has had difficulty in keeping abreast of the times. With a view, therefore, of bringing the operating engineer in closer touch with the finer details of modern practice, we have arranged with I. L. Kentish-Rankin to publish a series of short articles on this subject. The first of these under the heading of "Refinements of Practice in Modern Plants," will be found in the pages of this issue and should be of considerable interest to the engineer desirous of securing top notch efficiency in his plant.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

Agreeableness

By Dr. Frank Crane

IF YOU are looking for an order it may interest you to hear what is the one quality which everybody the world over wants most.

It is agreeableness.

It is worth money; for it sells more real estate, cigars, groceries, dry goods, automobiles, typewriters, furniture, and life insurance than any amount of smooth talk and convincing arguments.

Smile! Not once in a while, so that you look like it hurt you when you force a grin. But get the habit. Smile to yourself when you're shaving. Then it will come natural when you use it.

Be agreeable! And you'll be in demand. For in every walk of life they are crying for the agreeable person.

Every wife wants that kind of husband, husbands that kind of wife; children want agreeable parents, the workman an agreeable boss, the boss an agreeable workman, and everybody wants agreeable relatives.

Be agreeable, for you will have little competition and are pretty sure to succeed.

An agreeable person lights up the room like a lamp.

He is like the shade of a big tree on a hot day.

He is like a drink of something that tinkles in the pitcher when you're real thirsty.

He is like love when you're lonesome, bed when you're tired, a breeze when you're stifling, food when you're empty, and money when you're broke.

Be agreeable. Study to make people like you. Make love to the world.

Life's a mixup, anyway, that none of us understands. There are all sorts of inexplicable thorns and tragedies, buffets and chagrins. And most people are a bit sorry for themselves; hence, ugly.

But you—you be agreeable. Try it, and see what happens.

Copyright, 1921, by Dr. Frank Crane.

New Cold Junction Compensated Pyrometer

THE BROWN INSTRUMENT CO. is placing on the market a new thermo-electric pyrometer, which is automatically compensated in the instrument for changes in cold junction temperatures and which includes means of setting the pointer of the instrument to zero in the usual manner.

This is claimed to be an improvement on former methods of cold junction compensation developed by Darling in England in 1909, and an improvement on a few subsequent developments for automatic cold junction compensation brought out since that time. The means afforded for setting the instrument to zero is a most valuable feature.

Darling used what is called a Briguet spiral, a compound strip of two metals of different co-efficient of expansion. The Briguet spiral was used to move the scale dependent on the change in atmospheric temperature surrounding the instrument, or as an alternative, this Briguet spiral was mounted to act on the springs controlling the moving element of the galvanometer. Darling's device was never used to any extent because it was evident that unless an instrument had a means of setting to zero, serious errors might result in the use of the instrument.

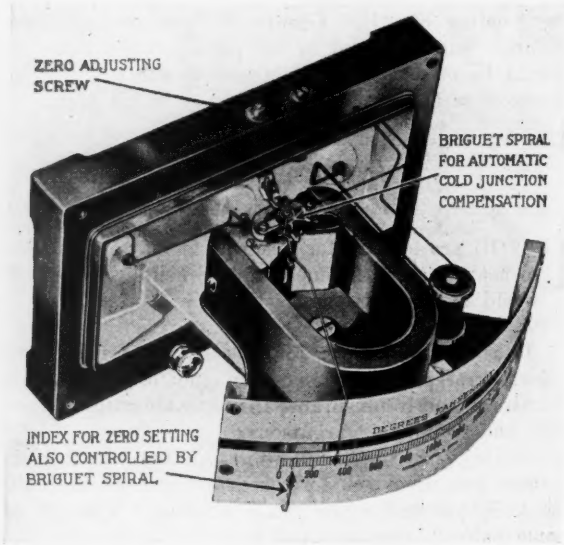

ZERO ADJUSTING SCREW
BRIGUET SPIRAL FOR AUTOMATIC COLD JUNCTION COMPENSATION
INDEX FOR ZERO SETTING ALSO CONTROLLED BY BRIGUET SPIRAL

FIG. 1. INTERIOR VIEW OF COMPENSATED PYROMETER

It is generally understood by all users of thermo-electric pyrometers that the millivoltage or electromotive force developed by a thermo-couple is dependent on the difference in temperature between the hot and cold ends of a thermo-couple. To secure accurate measurements of temperature, it is therefore necessary that the cold end of the thermo-couple be maintained at a constant temperature or the instrument must be compensated for the changes in temperature at the cold junction of the thermo-couple.

It is common practice to use what are known as extension or compensating leads, formed of material similar to the thermo-couple, which will transfer the cold junction from the binding posts of the thermo-couple to a distant point. Heretofore, it has been necessary to locate the cold junction at the end of the extension or compensating leads in a cold well in the ground or in a compensating box, where the temperature can be maintained constant.

In the instrument under consideration the extension or compensating leads are brought to the meter. Changes in temperature at the end of the extension or compensating leads also take place in the meter itself, which can be compensated for this change in temperature.

There are two methods by which this compensation can be easily secured. A portion of the scale of the instrument may be mounted on thermostatic material and moved, dependent on the change in temperature of the meter and in this way automatic compensation may be secured. Only a portion of the scale is moved and an index on the other portion of the scale denotes the normal zero of the instrument. In the second method a Briguet spiral similar to that used by Darling may be mounted in the instrument, controlling the springs and moving element directly, and a second index controlled by thermostatic metal may be mounted on the scale. This index works with change in temperature exactly in relation to the movement of the pointer controlled by the Briguet spiral attached to the moving element.

In using the new pyrometer it is only necessary to bring the compensating or extension leads from the thermo-couple to the instrument. After mounting the instrument, the instrument pointer is set by the zero adjuster to correspond with the index on the scale. If the values for a thermo-couple have been determined based on a cold junction of 75 deg. F., the index will indicate 75 deg. F., provided the instrument is subject to this surrounding temperature. If the instrument pointer does not correspond with this index, it is set accordingly. When the temperature surrounding the instrument and the cold junction of the end of the compensating leads at the instrument rises to 90 deg. F., the index automatically rises to 90 deg. F., and the Briguet spiral attached to the instrument pointer causes it to move up to 90 deg. F., automatically adjusting for the temperature of the cold junction of the thermo-couple.

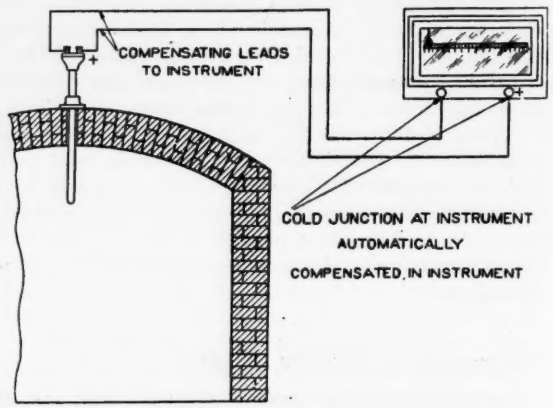


FIG. 2. WIRING DIAGRAM OF THE COMPENSATED PYROMETER

Any number of thermo-couples with their extension or compensating leads can be brought to the one instrument having this automatic compensation.

Turbo-Generator Operates Five Years with Only a Few Stops

FOR 5 yr. a 3200-kv.a. turbo-generator has been operating in the power plant of the City of Saskatoon, Province of Saskatoon, Canada, without a breakdown to mar the continuity of its performance. This, while not a record, indicates a sturdy mechanism that carried its load despite the severe handicap of extremes in temperature, which are common in that portion of Canada in which the generator is located.

The unit was installed by the Westinghouse Co. in 1914, being put into operation Nov. 24 of the same year. Except for a short period in the summer of 1919, it has been continuously available for service. Furthermore, the unit was not taken off the load at that time on account of mishap to the machine proper.

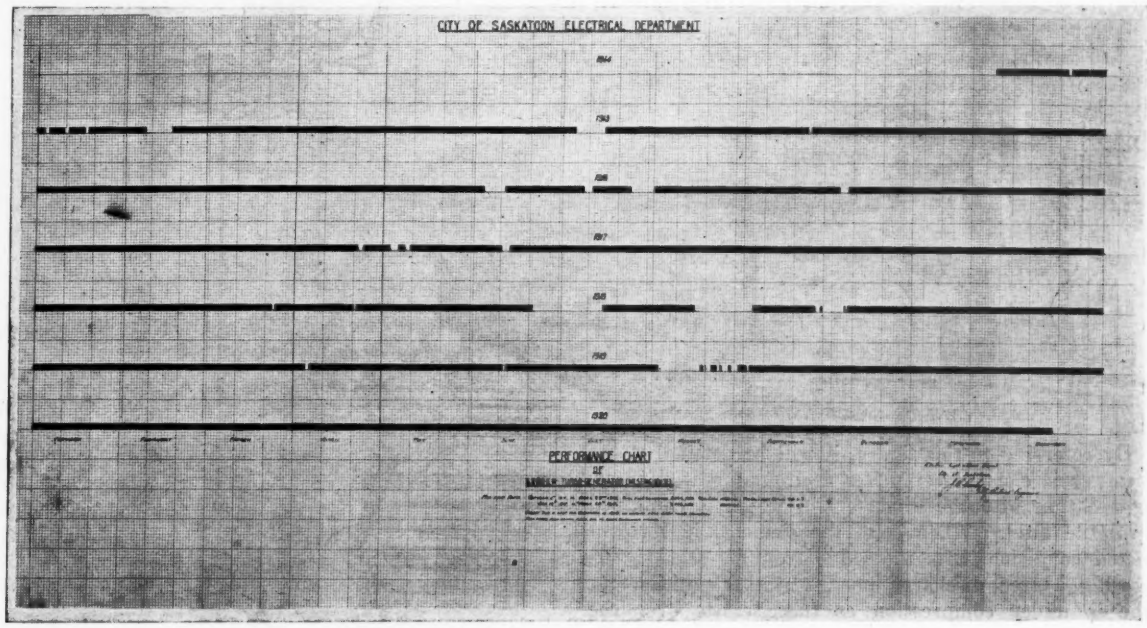
According to the chief engineer of the City of Saskatoon who is responsible for the performance chart which accompanies this article, the periods shown when the unit was not in operation are not on account of non-availability for service, but on account of the load being so light at the time that it could be carried by a smaller turbine.

Other performances are stated by city engineers. In summary, they show that the governor operated between extremes of load which varied from 300 to 2850 kw. in perfect control. The only portion of the entire equipment that was ever removed was the governor pedestal cap for the purpose of renewing a gasket on the gland runner joint. The condenser too, has proved reliable. On one occasion when ice shut off the water intake 17 times in an 8-hr. run, no trouble to the tubes or plates occurred under this unusual strain. The La Blanc air pump never has given any trouble with condensing water at a proper temperature, having shown that it was quite easy to run as low as point six from the barometer, at all loads. In conclusion, the chief engineer stated that the records of economies of this unit exceeded those guaranteed by the manufacturers.

Reference to the chart will show two runs of long duration. The first of these is from Oct. 6, 1916, to April 22, 1917, and the second from June 12, 1917, to March, 1918. In the first run, the load factor was 46.3 per cent while in the second, it was 46.6 per cent.

An inspection of the unit was made in August, 1920, at which time no replacements were necessary, as no wear was noticeable.

Since that time the chief engineer states that the unit has been operating satisfactorily and shows indications of an unusually long life.



PERFORMANCE CHART OF 3200-KW. TURBO GENERATOR

Automatic Water Wheel Generator

THE NEW ENGLAND POWER CO. is preparing to install an automatic control equipment for a 5000-kv.a. hydroelectric generating station to be located at Searsburg, Vt., on the Deerfield River.

The station will consist of one 5000-kv.a., 2300 v., three-phase, 60-cycle, water-wheel-driven generator with direct connected exciter, and automatic control, furnished by the General Electric Co., an I. P. Morris water-wheel, and a Woodward governor.

The voltage will be stepped up to 72,000 v. through a bank of three 1667-kv.a. single phase transformers, and will be tied in with the system of the New England Power Co., which is tied in with other systems and serves a large part of New England.

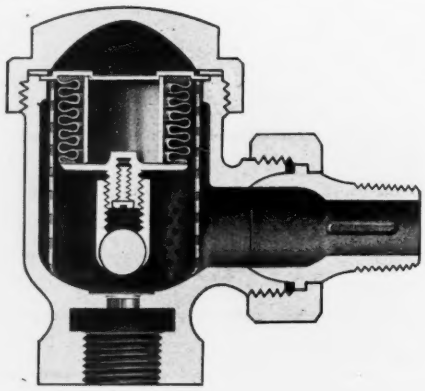
The station will be located in a mountainous, unsettled region, and will be practically inaccessible during a great part of the winter. The maintaining of properly trained and reliable operators under such conditions would prove difficult and expensive.

The automatic control will provide for starting and stopping the unit by means of a time switch. The gov-

ernor will be given a fairly drooping characteristic so that the unit will not only deliver approximately constant load, but will assist in regulating the system frequency. In case the water flow is less than that anticipated and provided for by an adjustment of the governor, a float switch will shut down the station. While the station is a relatively small portion of the system capacity, it will automatically feed into the system during the part of the day when most needed, but will not draw the pond level down to a point that will use the water inefficiently.

A New Radiator Trap

A NEW radiator trap recently placed on the market by the Sarco Co., Inc., for use in connection with vacuum, vapor and low pressure heating systems contains some features of design that are different from those of other traps for this purpose. A sectional view of this apparatus is shown in the accompanying figure.



SECTIONAL VIEW OF SARCO RADIATOR TRAP

By referring to this figure, it will be noted that the thermostatic element comprises a circumferentially corrugated tube of large diameter, in which is contained a volatile fluid. When cold, the element, in its contracted condition, lifts the valve from its seat ¼' in., allowing a free discharge port. In this position the tube is under compression as there exists over the volatile liquid a partial vacuum.

Steam entering the radiator heats the element and causes the fluid to evaporate, which gradually relieves the vacuum and builds up a pressure which extends the tube and moves the ball downward to its seat and holds it firmly there. When a sufficient amount of condensation has drained to the trap, the element cools, the pressure is released, the tube contracts and the valve is lifted, and the condensate is discharged to the return system.

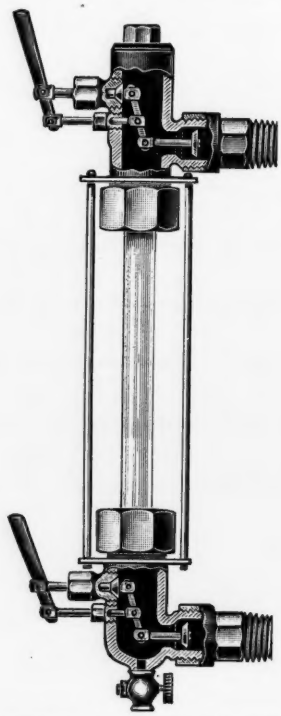
The valve seat is protected from grit and dirt by a screen surrounding the thermostatic element having a mesh area 10 times that of the valve seat. As the valve is spherical in shape and the seat conical, a line contact is secured between the two, and a tight seating results.

Another feature in the design is that the expansion element and the valve are not attached to either the body or the cap. The result is that they can be taken out and replaced readily without affecting the adjustment in any way.

Automatic Water Column Valve

THE MATTINGLY automatic valve, which has recently made its appearance on the market, is a valve which has been designed primarily to prevent the possibility of a false water level registration in the water column of a boiler, which often leads to disastrous explosions. The construction is exceedingly simple. The accompanying illustration serves to show its operation in connection with a water glass. Essentially the design comprises two valves, a main and an auxiliary. The main is a bevel disc valve which opens against boiler pressure, and the auxiliary is one similar in design which covers a port to the atmosphere. The two are connected by means of a first-class lever so that when one is open the other must be closed.

By pulling outward on the operating lever the main valve is opened and the auxiliary seated. Pressure then exerts itself on the auxiliary and keeps it closed and



PART SECTION OF A MATTINGLY AUTOMATIC VALVE AS INSTALLED ON A WATER COLUMN

at the same time keeps the other open. If the gage glass or any connection breaks, the pressure keeping the auxiliary closed is diminished and the flow closes the main valve.

When both main valves on the water and steam ends of the column are closed, the water is drained from the glass around the auxiliary valve stem which has no packing, thus warning the operator that the glass is not in communication with the boiler.

SEVENTY-FIVE per cent of all fires are preventable. Every year fire destroys enough buildings to house a city of 10,000 inhabitants, furnish them with their theaters, hospitals, public buildings, schools and asylums. One-fourth of all new construction is destroyed by fire annually.

Lightning Demolishes Substation

Resumption of Service Established in Remarkably Short Time

AT 6:25 a. m., Saturday, Sept. 24, lightning struck and completely demolished the Barrington (Ill.) substation of the Public Service Co. of Northern Illinois, cutting off the water, power and light service to Barrington and eight other nearby towns. Thereon McCready, the night operator, was the only person in the station at the time of the accident and was instantly killed.

Although several witnesses bear testimony to the fact that lightning struck the building, it is apparent that the complete destruction of the building was due to an explosion of some sort. As the accompanying photograph shows, absolutely nothing of the station was left standing. A heavy door, next to which McCready had been standing was blown fully 60 ft. across the road into a field.

McCready was to have been relieved by the day operator in about 30 min. and apparently was standing near the door watching the thunder storm when the bolt struck. A terrific explosion followed, and the walls of the building crumbled and fell. After the fire which had started in the debris had been extinguished by the fire department, McCready's bruised body was found near the door of the plant.

While reports were current that a large gas main pressure pump in the basement of the station had been leaking, and that the escaping gas was ignited by the lightning, there was no evidence to substantiate such rumors.

The plant was a 20,000-v. transformer substation, receiving current from Waukegan and Joliet, stepping it down to 8000 v. and 2300 v. for service and distribution to Barrington, Wauconda, Lake Zurich, Palatine, Arlington Heights, Algonquin, East and West Dundee and Carpenterville. These towns are supplied with light and power by this substation and practically all of them employ electric power for city pumping service. As a result, they were without water and light until steps could be taken to resume service. This, however, was effected in remarkably short time.

Immediately after the accident, the company put 75 men to work constructing a temporary wooden station. In the meantime, transformers and switching equipment were brought from Joliet and other nearby towns, and a crew of experienced electricians put to work on the installation of this apparatus. Three, 20,000/8000 v. transformers were erected outside, adjacent to the new wooden structure while instruments and switching equipment were installed inside. Line reactance coils, together with horn gaps and lightning arresters for the protection of the temporary equipment was mounted on a wood pole frame. This equipment can be seen in the photograph at the left hand corner of the new substation. The two 8000-v. circuits were connected up without change while the four original 2300-v. circuits were combined into two circuits as a temporary measure.

At 4:30 Sunday afternoon, most of the work on the temporary station had been completed and after having been out of service about 34 hr., service was re-established. Although erected hurriedly and although regulators had not been installed, the temporary station was giving full service Sunday night. Regulators are to be installed as soon as possible.

VIEW SHOWING RUINS WITH NEW TEMPORARY SUBSTATION IN THE BACKGROUND

THE SORE disappointments of today often prove grand blessings of tomorrow.

News Notes

THE COLLEGE OF ENGINEERING of the University of Illinois reports the following among the new appointments to its staff: William H. Severns as assistant professor of mechanical engineering, E. J. Crane as instructor in mechanical engineering, William Harris Foxwell as assistant in mechanical engineering, Frank C. Linn as assistant in mechanical engineering, John Dallas Wise as superintendent of the foundry laboratory, Russell James Englehart as assistant superintendent of the forge laboratory, William Ruprecht Osgood as instructor in theoretical and applied mechanics, Arthur Joseph Hoskin as research assistant professor of mining engineering, Thomas McLean Jasper as special research assistant professor of engineering materials on the investigation of the fatigue phenomena of metals, Joseph T. Tykociner as research assistant professor of electrical engineering, Rex Lenci Brown as research assistant in theoretical and applied mechanics, Floyd B. Hobart as research assistant in chemical engineering, George Theodore Felbeck as research assistant in mechanical engineering, Crandall Zachariah Rosecrans as research assistant in mechanical engineering, Norman Boynton Green as research graduate assistant in theoretical and applied mechanics, George Toel Lorance as research graduate assistant in physics, Koppel Schapiro as research graduate assistant in civil engineering, and Otis Gayle Stewart as research graduate assistant in mining engineering.

THE AMERICAN DISTRICT STEAM CO. of No. Tonawanda, N. Y., has moved its New York City office from 280 Madison Ave. to 30 Church St.

THE BETSON PLASTIC FIRE BRICK CO., INC., of Rome, N. Y., has moved its New York City offices from 13 Astor Place to 50 Church Street.

THE HOOVEN, OWENS, RENTSCHLER CO. has recently appointed the following sub-agents: The Wisconsin River Supply Co., Wausau, Wis.; E. D. Morton and Co., Louisville, Ky., and George F. Motter's Sons, York, Pa.

THE WESTINGHOUSE Electric International Co. announces that it has received final confirmation of the contract to supply the equipment to electrify the Chilean State Railroad between Valparaiso and Santiago, and the Los Andes branch. This contract covers the most important railway electrification undertaken since the beginning of the war, and is said to be the largest ever undertaken by an American firm outside of the United States.

The main line, which is 116 mi. long, is now under steam operation. It connects the leading seaport (Valparaiso) with the capital (Santiago), while the line to Los Andes is 28 mi. long, and forms the Chilean State Railway section of the trans-continental line to Buenos Aires. The contract has a total value of $7,000,000 and was secured by keen competition from Germany and other European companies. The equipment to be furnished consists of 11 local passenger locomotives, 15 road freight locomotives, seven switching engines, and five sub-stations of 4000 kw. capacity each. The 3000-v. d.c. system which will be used will be strictly American in character.

Other American concerns who received contracts for requirements of the Chilean Railroad are the American Locomotive Co., Pressed Steel Car Co., and the Anaconda Copper Mining Co.

GOETZE GASKET & PACKING CO., New Brunswick, N. J., announces the opening of a branch office under the management of the Sheffler-Gross Co. at Philadelphia, Pa.

ON NOV. 1 the Quaker City Rubber Co. will move into its new modern Quaker Building, 624 Market St., Philadelphia. This company has been located on Market St. for considerably more than a quarter century, and this new building will house the main offices and salesrooms.

EARL F. HEIMPEL, formerly chief engineer of the Edison Portland Cement Co., Stewartsville, N. J., has resigned to enter the sales force of the M. J. Dougherty Co. of Philadelphia. Mr. Heimpel, who is a graduate of Lehigh University, has had a wide and varied experience in the engineering field and will be located in the home office.

Catalog Notes

"LUBRICATION of the Steam Turbine" is the title of an interesting 36-page booklet recently issued by The Texas Co. It is not a theoretical treatise intended for students, but is a practical discussion for men who use oil.

Important items, such as lubricating methods, oiling systems, effects of heat, water, deposits, cleaning, starting, oil coolers, reduction gears, etc., are taken up in logical sequence. It also contains recommendations as to kinds of oils to use and diagrams of practical oiling systems.

The book will be sent to turbine operators or mechanical executives upon request.

OPERATION, construction and safety features of type A auto-starters are given in leaflet 1610-C, which is being reprinted by the Westinghouse Electric & Manufacturing Co. This leaflet describes in detail the auto-transformer, switching mechanism, the contacts, the overload relays, and many other features of this apparatus.

Leaflet 1888-A, just published, describes the applications of storage battery mine locomotives, and illustrates and treats on the Baldwin-Westinghouse type of apparatus.

PAMPHLET DT-1601, just issued, entitled, "Tight in Two Places," describes Yarway Double Tightening Valves, which can be used on acid lines, soot blowing systems, for locomotive service and pneumatic systems, in addition to boiler blowoff use. Copies of this pamphlet will be sent to anyone interested, addressing Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.

STRONG MACHINERY & SUPPLY CO., New York, recently issued Catalog No. 10 containing illustrations, description and price lists of the company's packings, gage glasses, calking tools and other specialties.

CRANE PACKING CO.'S latest booklet on the "John Crane" metallic packing process, its developments and correct application to surface condensers, heaters, evaporators, intercoolers, etc., has just been received.

RADIATOR TRAP Sarco, Type E, for vacuum, vapor and low pressure steam heating systems, is discussed in a new circular from Sarco Co., Inc., of New York City.